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Especially when using older guidebooks in this collection, note that locations may have changed drastically. Likewise, geological interpretations may differ from current understandings.

Please respect any trip stops designated as “no hammers”, “no collecting” or the like.

Consider possible hazards and use appropriate caution and safety equipment.

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NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE

PL. VII

Moores Lith. Boston

Graeter del.

KATAHDIN
1966

NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE.

The New England Intercollegiate Geological Conference is perhaps the oldest continuous "organization" on the continent whose sole aim is geological field trips. It began with an informal field trip in 1901, run by William Morris Davis in the Connecticut Valley of western Massachusetts, and gradually extended itself (Connecticut, 1903; eastern Massachusetts, 1905; Rhode Island, 1907; New Hampshire, 1910) over New England and eventually outside to such foreign parts as Montreal and New York City. Attendance at the early meetings is unknown but was probably small; nowadays it runs to 250 or better. The length of the group's name is equalled only by the looseness of its organization. Its purpose remains to arrange for field trips in areas where geological work has recently been done, and to bring together in the field geologists interested in current problems of New England geology.

John Rodgers, Secretary, N.E.I.G.C.

Cover Illustration:

MOUNT KTAADN from W. BUTTERFIELD'S *(Oct. 8th, 1836)*

Near the GRAND SCHOODIC LAKE

Plate VII of Atlas of 24 plates, separately bound, which accompanies Jackson, Charles T., First report on the geology of the State of Maine, Augusta, Maine, 1837.

NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL CONFERENCE

GUIDEBOOK

for field trips in

THE MOUNT KATAHDIN REGION, MAINE

Field Trip Leaders

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58th Annual Meeting
September 29, 30, October 1, 1966

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INTRODUCTION AND ACKNOWLEDGEMENTS.

Members of the N.E.I.G.C. are welcomed to the Mt. Katahdin region, not by an institution, but by the several geologists who are very glad to share with the conference the results of their recent studies here. We are also happy to demonstrate, particularly to the younger members of the Conference, that, in this electronic age, many significant contributions to geologic knowledge can still be made using the time-honored tools of the geologist; his legs and his hammer.

For the first time in a number of years, the Conference is without an official host. Also missing this year will be the elaborate banquets, the comfortable surroundings, the efficient bus trips and the high-rank metamorphic rocks to which attendees of Conferences in recent years have become accustomed. In their stead we can offer outdoor cooking, tents, leantos and rustic cabins, long hikes and fossiliferous sedimentary rocks.

The modern, detailed geologic investigation of the Mt. Katahdin region began in the middle 1950's when Caldwell, Griscom and Rankin, then graduate students at Harvard University started their field studies. In the late 1950's and early 1960's, Neuman of the U. S. Geological Survey mapped the geology of the Shin Pond and Staceyville Quadrangles to the east and northeast of Katahdin. Griscom and Rankin subsequently joined the U. S. Geological Survey, which has published many of the results of their studies. In 1961 Hall, then a graduate student at Yale University, began mapping in the Chamberlain Lake region northwest of Katahdin. The recent studies of both Hall and Caldwell in this area have been supported by the Maine Geological Survey.

During the previous winter and spring months, Brad Hall took over the many chores associated with the organization of this conference and I gratefully acknowledge his very considerable contributions. The Department of Geological Sciences, University of Maine made available its facilities to Dr. Hall in his organizational labors. The Maine Geological Survey provided welcome assistance in the processing of registration forms and the distribution of guidebooks. John R. Rand, Freeport, Maine and Linwood Partridge, Maine Department of Economic Development aided in the design and layout of the guidebook cover. The contributions of each of the field trip leaders are so obvious and at the same time so vital, that it is impossible for me to acknowledge them adequately.

D. W. Caldwell, guidebook editor

EARLY ASCENTS AND GEOLOGIC EXPLORATION OF KATAHDIN IN THE NINETEENTH CENTURY[1]

By Andrew Griscom, U. S. Geological Survey

About 90 miles upstream from Penobscot Bay, the Penobscot River divides into the West Branch and the East Branch. Between these two branches are located the highest mountains in Maine. In the past, the mountains, especially Katahdin, provided impressive changing views to the Indians, who used the rivers, in particular the West Branch, as highways to the interior. John Giles saw Katahdin while a captive of the Indians a few years before 1700, and wrote in 1736:

"I have heard an Indian say that he lived by the River at the Foot of the Teddon, and in his Wigwam, seeing the top of it thro' the Hole left in the top of the Wigwam for the passing of Smoke, he was tempted to travel to it; accordingly he set out early on a Summer's Morning, and laboured hard in ascending the Hill all Day, and the Top seem'd as distant from the Place where he lodged at Night, as from the Wigwam whence he began his Journey; and concluding that Spirits were there, never dare make a second Attempt.

"I have been credibly inform'd that several others have failed in the same Attempt; particularly, that three young Men towr'd the Teddon three days and an half, and then began to be strangely disorederred & delirious, and when their Imagination was clear, and they could recollect where they were, and been, they found themselves return'd one Days Journey; how they came down so far, and they can't guess, unless the Genii of the Place conveyed them."

The earliest Survey in the Katahdin region of which we have record is described in the journal of Joseph Chadwick, who probably made a partial ascent of Katahdin in 1764 while returning from Quebec via the Penobscot West Branch. The name he uses for the mountain is a variant of Nesowadnehunk (usually pronounced "Sowdyhunk"), the deadwater on the West Branch from which the pyramidal outline of Katahdin is visible:

"SATINHUNGEMOSS HILL

Lays in the Latitude of 45° 43′ and from Fort Pownal 184 miles as we travel and 116 miles by Computation.

Being a remarkable Hill for highteth & figr The Indines say that this Hill is the highest in the country. That they can ascend so high as any Greens Grow & no higher. That one Indine attempted to go higher but he never returned.

The hight of Vegetation is as a Horizontal Line about halfe the perpendiciler hight of the Hill & intersects the tops of Sundrey other mountines. The hight of this Hill was very apperent to ous as we had a Sight of it at Sundre places Easterly & Westerly at 60 or 70 Miles Distance—It is Curious to See—Elevated above a rude mass of Rocke large Mountins—So Lofty a Pyramid—On which is another Rarity.

From a. Descendes a Stream of water.—If the observer places himselfe at such a place that the Rays of water as it falls from the hill will appear in as grate a Voriety of Collers as may be Viewd in a Prism glass."

Eckstorm (1926) interprets Chadwick's descriptions of the waterfall rainbow and the superstitions of the Indians as indications of an attempted ascent that was discouraged at the timberline by the Indian guides. The locality of the waterfall is uncertain, but Katahdin Falls on Katahdin Stream is a reasonable possibility.

On August 13, 1804, Charles Turner, Jr., a surveyor from Scituate, Massachusetts, and later a member of Congress, ascended Katahdin with a group of surveyors who were engaged in locating the grants of Eastern Lands. Turner's account is generally considered to be that of the first ascent, although his description implies earlier explorations by the English of which there are no known records. The route of ascent was the Hunt Trail spur, the great southwest slide not yet having occurred, and the party with pardonable enthusiasm estimated the height of the mountain as 13,000 feet.

[1] Publication authorized by the Director, U. S. Geological Survey.

Efforts to settle the boundary controversy between Maine and New Brunswick led to the next two ascents of Katahdin by official government surveyors in order to establish whether or not the mountain was situated on a major drainage divide. Major Colin Campbell, a surveyor for Great Britain, ascended the mountain in 1819 and again in 1820, this time in the company of a joint party of British and United States surveyors. The major demonstrated a certain bias in his report by stating (Greenleaf, 1829, p. 29-31) that the view indicated a chain of mountains or divide extending from Katahdin northeast to Mars Hill in Aroostook County, thus laying claim to all land northwest of this divide for England. A detailed account of the ascent was not found until 1958, when a manuscript by Daniel Rose, last mentioned in 1883 by J. D. Elder, was located and acquired by the Bangor Public Library. The British surveyor William F. Odell was the only man whose glass barometer tube survived the 1820 ascent and the party jointly arrived at a rather accurate figure of 5,335 feet for the summit elevation. These two successive climbs were made via the great southwest slide which formed either in 1816 or a few years before and was over 4 miles long. The present Abol Trail follows the upper portion of this slide, now mostly reforested.

The surveying in 1825 of the Monument Line, an east-west base line for the location of townships in the northern part of the state (Avery, 1928), resulted in the first ascent of Katahdin from the East Branch. Joseph C. Norris and his surveying party began working west from the New Brunswick border in the summer of 1825 and discovered that by misfortune their chosen line led directly over the Tableland of Katahdin. Norris finally on November 10, in bitter winter weather and out of supplies, abandoned his survey for that season on the west side of the Tableland above the cliffs of Northwest Basin. The following day the surveyors ascended Katahdin from the north, and after circling down to the southwest, encountered the southwest slide and descended to the West Branch, where a boatload of supplies was waiting for them. They barely managed to canoe down the West Branch to Bangor before the river froze for the winter. In 1826 Norris completed the Monument Line from Chesuncook Lake west, but he left a gap between the lake and Katahdin. The gap was not surveyed until 1833, when Edwin Rose, a surveyor for the State, made the sixth recorded ascent of the mountain. The half-mile offset of the Monument Line near Doubletop Mountain represents the error in Norris' 1826 estimate of where the Line would intersect Chesuncook Lake.

The fifth ascent of Katahdin, by a survey party from Waldo County, is briefly mentioned by Greenleaf (1829). This party computed the height of Katahdin as 5,623 feet.

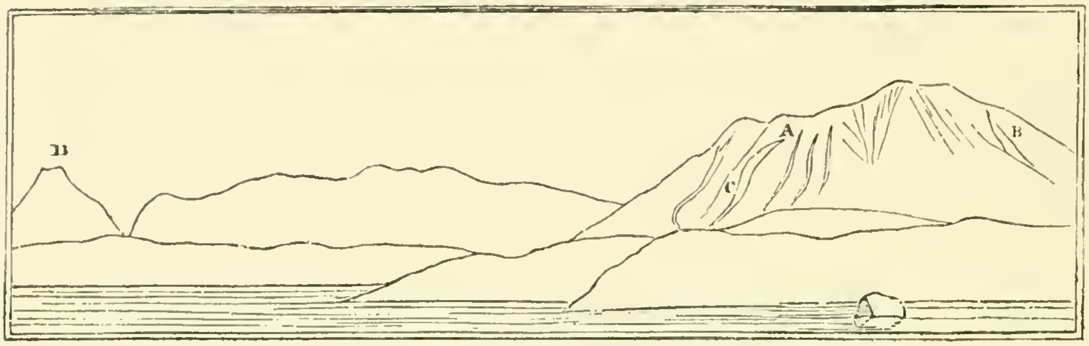
In 1836 Professor Jacob W. Bailey of West Point visited Katahdin in order to make geologic observations concerning the mountain, being unaware of the geological survey of the state proposed for the following year.[2] He described the southwest slide (his "West Slide," Bailey, 1837, p. 28) as follows:

"Here a scene of wild confusion presented itself; masses of granite, shivered by their fall from above, lay scattered over the path of the slide; all traces of the original soil and vegetation were swept away, so that the denuded ledges of granite appeared in some places, while in others they were covered with great quantities of a coarse gravel, evidently produced by crumbling of some of the coarse varieties of granite, much of which was seen in a state of partial disintegration."

[2] In Figure 1 is shown a sketch of Mt. Katahdin which appeared in Bailey's account (Bailey, 1837) of his expedition. According to Griscom (personal communication), this sketch is ". . . perhaps the earliest published view . . ." (of Mt. Katahdin). Ed.

Figure 1

Outline of Mount Katahdin, as seen from Debskoneegan Lake.



A, West Slide.—B, East Slide.—C, Camp.—D, Sugar Loaf.

Bailey ascribed the occurrence of fossiliferous limestone, graywacke, and amygdaloidal fragments in the slide to diluvial action and noted that the summit was composed of red granite.

Subsequent to Bailey's ascent, visits to Katahdin were made more frequently; in what follows, the discussion will emphasize only nineteenth century expeditions which have some relevance to the geology of the mountain. It can be noted in passing that one of the earliest mentions of the geology of the region is found in Greenleaf (1829, p. 116), who states somewhat optimistically concerning the sandy limestone beds at Ripogenus Gorge: ". . . an extensive bed of fine statuary marble forms a part of the bed of the west branch of the Penobscot, a little below the Chesuncook."

Dr. Charles T. Jackson (during the first geological survey of Maine) reached the top of Katahdin, via the southwest slide, on September 23, 1837, in a snowstorm and short of provisions. He observed that the mountain was composed entirely of biotite granite (Jackson, 1838) and stated his belief, based on erratic boulders in the upper part of the slide, that the drift had passed over the top of the mountain. The cause of the drift was not to be understood for many years.

In 1846 the Rev. Marcus R. Keep opened up the route from the east, clearing a trail to be known as the Keep Path; he later explored the eastern cirques of the mountain.

Henry David Thoreau described in The Maine Woods (1864) a partial ascent of Katahdin on September 8, 1846. He quoted Jackson concerning the geology of the mountain and, like Jackson, was greeted at the edge of the Tableland by a mountain capped with clouds (ibid., p. 63-64):

". . . I was deep within the hostile ranks of clouds, and all objects were obscured by them. Now the wind would blow me out a yard of clear sunlight, wherein I stood; then a gray dawning light was all it could accomplish, the cloud-line ever rising and falling with the wind's intensity. Sometimes it seemed as if the summit would be cleared in a few moments, and smile in sunshine: but what was gained on one side was lost on another. It was like sitting in a chimney and waiting for the smoke to blow away. It was, in fact, a cloud-factory,—these were the cloud-works, and the wind turned them off done from the cool, bare rocks."

In 1861 Charles H. Hitchcock, in the course of a geological survey of the state, ascended Katahdin by way of Avalanche Brook, the East Slide, and the Knife Edge (in one of the last groups guided by the Rev. Mr. Keep). Hitchcock observed the red granite at the summit, capping the white granite found at lower elevations. He doubted that the drift had completely passed over Katahdin because of the sharp outline of the Knife Edge.

John K. De Laski, who visited the mountain with the Young botanical expedition in 1847 and again in 1871, believed that the continental ice sheet overrode the summit of Katahdin (De Laski, 1872). Alpheus S. Packard, entomologist with the Hitchcock party and later professor of geology at Brown University, also supported the concept of a continental ice sheet as the cause of the drift (Packard, 1867).

A great advance in Katahdin geology was marked by the paper of Charles E. Hamlin (1881) describing the results of his visits to Katahdin in 1869, 1871, 1879, and 1880. Here are found the first thin-section descriptions of the red and gray granites (by M. E. Wadsworth, then assistant to N. S. Shaler at Harvard University and a pioneer in microscopic petrography), mention of the gradational contact between the two color varieties, and a discussion of the abundant biotitic inclusions. Finding glacial erratic boulders only up to an elevation of 4,615 feet, Hamlin felt the evidence left unsettled the question as to whether the drift passed over Katahdin, but he did recognize that local valley glaciers had been present and had deposited terminal moraines at the exits of the basins.

The problem of the ice sheet overtopping Katahdin was finally settled by Ralph S. Tarr (1900), who, during expeditions to Katahdin in 1897 and 1899, found foreign rock fragments at the summit. He also provided a more complete description of the effects of the local valley glaciation on the east side of Katahdin and explained that this local glaciation occurred subsequent to the continental ice sheet.

With the publication of Tarr's results, the preliminary investigations of Katahdin geology were complete. Little more information was obtained during the next half century. Interested readers are referred to the splendid annotated bibliography of Katahdin by Smith and Avery (1936).

Geologic research during the twentieth century, begun by graduate students of Harvard University in the 1950's, is discussed by other papers.

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BEDROCK GEOLOGY OF THE SHIN POND REGION[1]

By Robert B. Neuman and Douglas W. Rankin
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Introduction

Low-rank metamorphism and the presence of fossils make the geology of northeastern Maine a key to the understanding of the more metamorphosed rocks of southern New England. The Shin Pond region, consisting of the Shin Pond and surrounding quadrangles, contains many of the critical elements of that key.

The region affords the longest, most nearly complete, and most accessible section in the State, and it contains one of the largest masses of felsic volcanic rocks in the United States. Because facies change abruptly within short distances and because many critical relations are exposed in inaccessible places, the features to be seen along the routes of the trips are but random and incomplete samples of the information upon which the understanding of the geology of this area is based.

The geology of the four contiguous quadrangles to be visited has been mapped at a scale of 1:62,500 in recent years. Neuman mapped the Shin Pond and Stacyville quadrangles for the U. S. Geological Survey in 6 summer field seasons ending in 1963; he has been especially interested in Ordovician stratigraphy and paleontology. Rankin mapped the Traveler Mountain quadrangle, with special emphasis on the volcanic rocks of Traveler Mountain, for a dissertation at Harvard University, supported in part by the Maine Geological Survey, in 5 seasons ending in 1961. The Island Falls quadrangle, east of the Shin Pond quadrangle, was mapped in 1958-1962 by E. B. Ekren and F. C. Frischknecht of the U. S. Geological Survey, using electromagnetic equipment as a supplement to surface observations. More than a dozen papers by these geologists on one or another aspect of their work have been published. Professional Papers and accompanying geologic maps on the U. S. Geological Survey work have been prepared and are now being processed for publication. Further, all but the mountainous area is covered by recent aeromagnetic maps of the U. S. Geological Survey.

We wish here to acknowledge the essential role of Arthur J. Boucot, now of the California Institute of Technology, in determining and interpreting Silurian and Lower Devonian brachiopods, and thus in establishing the relative ages of many of the units mapped. Graptolites in considerably fewer numbers were identified by W. B. N. Berry (University of California, Berkeley) whose assistance we also gratefully acknowledge.

Major tectonic features

The major structures of the region are the large anticlinorium that extends northeastward from the Stacyville quadrangle across the southern half of the Shin Pond quadrangle (the southwestern end of the Weeksboro-Lunksoos Lake anticline of Pavlides and others, 1964) and the complementary synclines to the northwest and southeast (figs. 1 and 2). Lower Cambrian(?) and Ordovician rocks are exposed in the core of the anticlinorium. On the northwest flank of the anticlinorium the Silurian sequence includes distinctive calcareous sedimentary rocks, conglomerate, and volcanic rocks that are overlain by Lower Devonian siltstone, sandstone, the volcanic rocks of Traveler Mountain, and the overlying sedimentary rocks that

[1] Publication authorized by the Director, U. S. Geological Survey.

were derived from them. On the southeast flank of the anticlinorium, by contrast, the Silurian rocks are largely a monotonous assemblage of slate, siltstone, and fine-grained sandstone, without volcanic rocks, and with little limestone or conglomerate; in this region, no sedimentary rocks of Devonian age have been identified.

Most of the rocks are deformed and metamorphosed to the chlorite grade of regional metamorphism. Metamorphism and deformation are least in the Traveler Mountain volcanic rocks and the overlying Trout Valley Formation of Dorf and Rankin (1962), the latter being remarkably little disturbed.

The rocks of the Lower Cambrian(?) Grand Pitch Formation are intricately folded and faulted and are more deformed than those of overlying formations. Argillaceous rocks of the Grand Pitch possess a well-developed cleavage, and sandstones are commonly sheared. In many places cleavage is folded; in some of these cleavage folds the earlier cleavage is cut by a second one. Argillaceous rocks with interbedded sandstone also occur at the base of the overlying Ordovician Shin Brook Formation at a few places, but they are not as complexly deformed as those of the Grand Pitch. At other places the lower part of the Shin Brook contains conglomerate composed of fragments of slate and quartzite almost certainly derived from the Grand Pitch.

Both the deformation contrast and the composition of the conglomerate indicate that a tectonic event separated the deposition of these formations. Deformation contrasts between rocks that may be correlative with the Grand Pitch and overlying Ordovician rocks have been described elsewhere in the northern Appalachians (Cooke, 1955; Riordon, 1957; Larrabee and others, 1965, p. E-8). Such a contrast through this large an area suggests tectonic activity of regional extent at some time between the Early Cambrian and the Early Ordovician; the term Penobscot disturbance is proposed for this event.

If the contrast of deformation between the Grand Pitch and younger formations is ascribed to the Penobscot disturbance, the effect of the younger Taconic orogeny in this area is seen largely in, (1) the distribution of Ordovician rocks, (2) the facies pattern of the Silurian rocks, and (3) the occurrence of a pre-Lower Silurian porphyritic quartz diorite. The absence of Ordovician rocks beneath the Silurian in most places along the northwest flank of the anticlinorium might be attributed to Taconic uplift and erosion. This event may also be responsible for the apparent wedge-out of Ordovician rocks at the southwestern end of this outcrop belt. The contrasting facies of contemporaneously deposited Silurian rocks on opposite sides of the anticlinorium indicate that an ancestral form of this anticlinorium developed during the Taconic and remained to separate the Silurian basins of deposition. Fragments of the porphyritic quartz diorite in Lower Silurian conglomerate on the southeast flank of the anticlinorium were probably locally derived and indicate the minimum age of that intrusive.

The Acadian orogeny was the last to affect the area. Through most of the region, Acadian structure is characterized by nearly vertical, well-developed slaty cleavage and shear surfaces; folds are the dominant major structures, but there are significant contrasts in the style of folding on opposite sides of the anticlinorium, and faults are important features in some places. On the southeast flank of the anticlinorium most beds as well as cleavage stand nearly vertically; axes of minor folds and bedding-cleavage intersections are generally vertical. By contrast, on the northwest flank, bedding over wide areas dips moderately, and major as well as minor folds have moderate plunges. Curiously, over a considerable area, minor folds plunge

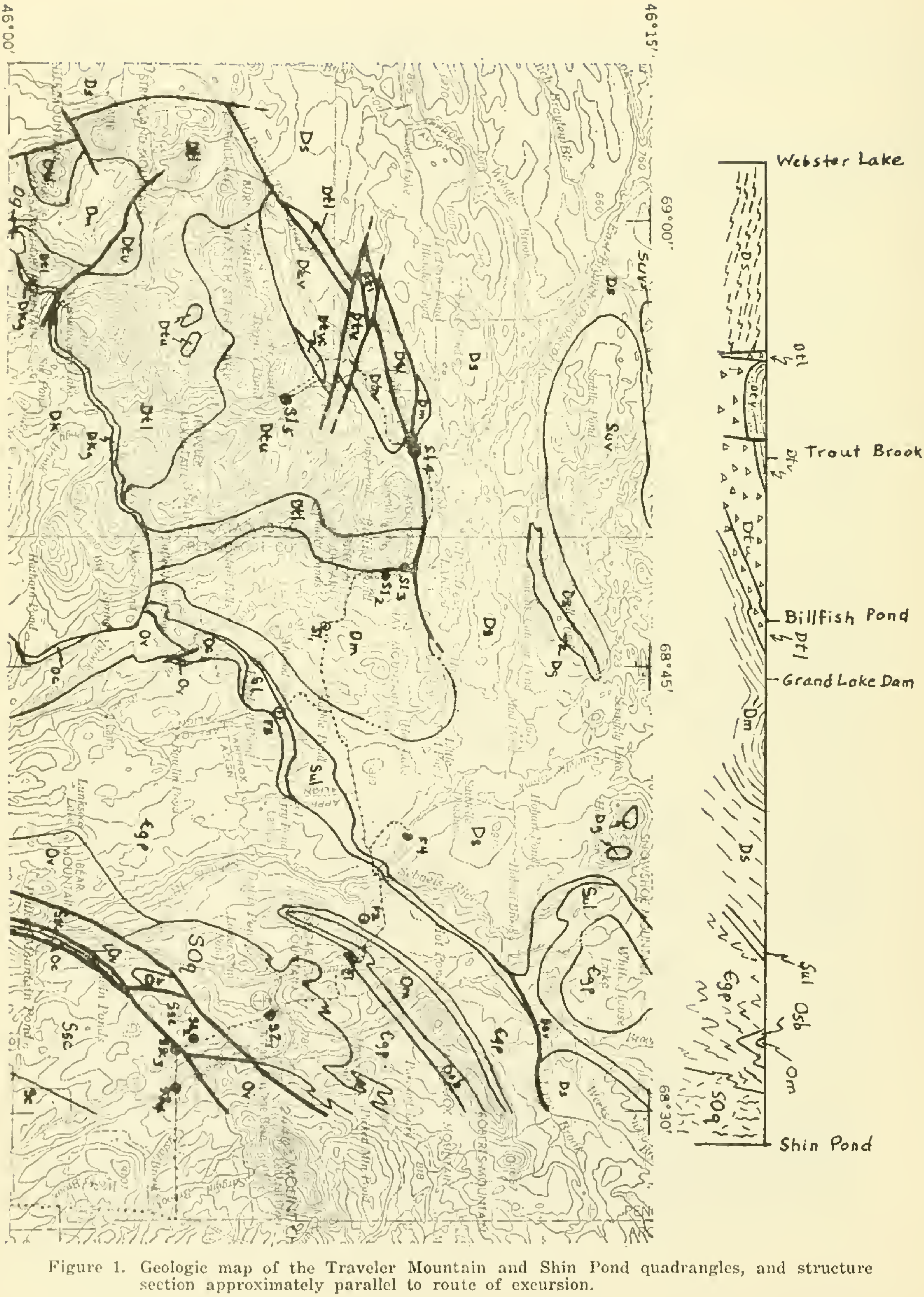

Figure 1. Geologic map of the Traveler Mountain and Shin Pond quadrangles, and structure section approximately parallel to route of excursion.

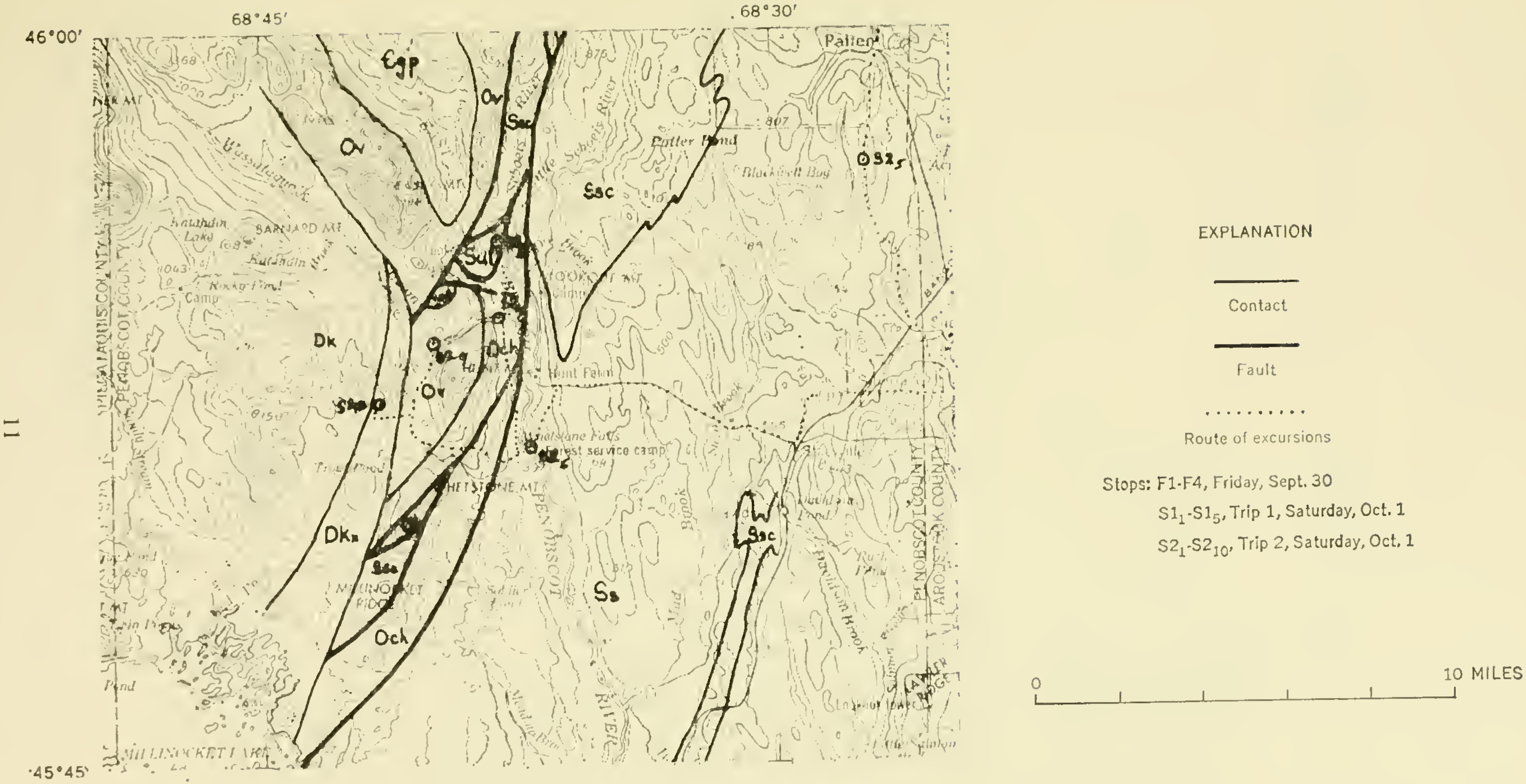

Figure 2. Geologic map of the Stacyville quadrangle

EXPLANATION

SEDIMENTARY AND EXTRUSIVE ROCKS

INTRUSIVE ROCKS

SOUTHEAST OF ANTICLINORIUM

NORTHWEST OF ANTICLINORIUM

Lower Devonian

Dtv — Dtvc

Trout Valley Formation of Dorf and Rankin (1962)
Dtv-Shale, siltstone, and sandstone;
Dtvc-conglomerate

ACADIAN UNCONFORMITY(?)

Dtu / Dtl

Quartz latite of Traveler Mountain
Dtu-Porphyritic quartz latite with quartz phenocrysts rare or absent; lava. Dtl-Porphyritic quartz latite with abundant quartz phenocrysts; ash flow tuff

Dm

Matagamon Sandstone
Thick-bedded, fine- to medium-grained feldspathic sandstone

Ds

Seboomook Formation
Graded beds of fine-grained sandstone and dark siltstone

DSv

Mafic volcanic rocks

Dkg — Dk — Dkx

Quartz monzonite of Mt. Katahdin
Dk-granoblastic rocks; Dkg-granophyric rocks; Dkx-border phase with abundant xenoliths

Dg

Granophyre
May be equivalent to volcanic rocks of Traveler Mountain

DEVONIAN

SILURIAN OR DEVONIAN

SILURIAN

Lower and Upper Silurian

Ss

Slate, siltstone, and minor sandstone

Ssc

Sandstone and conglomerate
with minor slate

Suv Sul

Suv-mafic volcanic rocks, including
flows, tuff, and conglomerate; Sul-calcareous
siltstone, limestone and conglomerate

Sl

Conglomerate, sandstone, and
non-calcareous siltstone

TACONIC UNCONFORMITY

SOq

Porphyritic quartz diorite

ORDOVICIAN

Upper Ordovician

Oc

Conglomerate, sandstone, and
calcareous siltstone

CORE OF ANTICLINORIUM

Middle Ordovician

Och

Chert with subordinate felsic
pyroclastic rocks

Ov

Mafic volcanic rocks (greenstone)

Om

Metadiabase

Lower or
Middle Ordovician

Osb

Shin Brook Formation
Tuff, tuffaceous sandstone,
and conglomerate

PENOBSCOT UNCONFORMITY

CAMBRIAN(?)

Lower Cambrian(?)

Cgp

Grand Pitch Formation
Gray, green, and red slate,
quartzite, and graywacke

northeast whereas major folds plunge southwest. The structurally competent Matagamon Sandstone and the quartz latite of Traveler Mountain are folded together with the beds below, but these competent rocks show the effects of deformation or metamorphism less. The Trout Valley Formation is so little deformed that it may postdate the Acadian orogeny.

More certainly younger than Acadian folding is the quartz monzonite of Mount Katahdin and its bordering breccia.

Stratigraphy

Only those formal stratigraphic names that are unequivocally in good standing are used in this guidebook; nomenclatorial revision or clarification is deferred to other more appropriate publication, as is the introduction of the new names that will be used in the forthcoming U. S. Geological Survey publications.

CORE OF ANTICLINORIUM

Grand Pitch Formation (Neuman, 1962): Gray, green, and red slate and siltstone, and about equal amounts of vitreous quartzite and lesser amounts of graywacke and tuff. Contains the trace fossil *Oldhamia smithi* Ruedemann in red slate at several places along the East Branch of the Penobscot River. *Oldhamia* occurs with Early Cambrian body fossils in the Weymouth Formation in Massachusetts (Howell, 1922), but it is the only fossil in such formations as the "Nassau Beds" of Ruedemann (*in* Cushing and Ruedemann, 1914, p. 70) in New York, and the Bray Slate in Eire (Tremlett, 1959, p. 62) for which a late Precambrian age cannot be excluded. Minimum thickness, 5,000 feet.

Shin Brook Formation (Neuman, 1964): Tuff, tuffaceous sandstone and conglomerate, breccia, and flows. Tuff, the most common rock, is massive, greenish-gray, and porphyritic; contains altered stubby to anhedral altered plagioclase phenocrysts up to 2 mm in cross section; it is of intermediate composition, in the andesite-dacite range. Fossils, mostly brachiopods, and fewer trilobites, bryozoans, gastropods, and sponges, occur in the sandstone and tuff at different levels from place to place. Study of the brachiopods by Neuman (1964), and of the trilobites by Whittington (*in* Neuman, 1964) indicated a late Early or earliest Middle Ordovician age. Thickness variable, 300 to 2,500 feet.

Ordovician mafic volcanic rocks (greenstone): Largely massive metamorphosed basalt, andesite, and dacite; locally pillow lava and flow breccia. Thickness where present, 1,000 to 2,500 feet.

Chert with subordinate felsic and mafic pyroclastic rocks: Thin-bedded, medium-to dark-gray, greenish-gray, and red chert; tuff and tuff breccia interbedded locally. Siliceous shale interbeds contain graptolites of the *Climacograptus bicornis* and *Orthograptus truncatus* var. *intermedius* Zones, and conodonts and inarticulate brachiopods. Estimated thickness, 300-1,500 feet.

Ordovician conglomerate, sandstone, and calcareous siltstone: Polymict boulder to pebble conglomerate containing fragments of volcanic rocks, slate, quartzite, and quartz pebbles, and gray sandstone and calcareous siltstone. Exposed principally along the East Branch of the Penobscot River (including Haskell Rock Pitch), where it overlies mafic volcanic rocks and is presumably overlain by Lower Silurian conglomerate; wedges out northeastward. Contains brachiopods, trilobites, and corals of Late Ordovician (Ashgill) age. Maximum thickness about 1,500 feet, but thins abruptly to extinction.

NORTHWEST FLANK OF ANTICLINORIUM

Lower Silurian conglomerate, sandstone, and siltstone: Thick-bedded polymict quartzose pebble conglomerate, micaceous sandstone, and gray and red siltstone and slate; wedges out northeastward along outcrop belt. Conglomerate contains large thick-shelled brachiopods, such as *Pentamerus* sp. and *Stricklandia lens ultima* Williams. As much as 800 feet thick, but thins to extinction.

Upper Silurian calcareous siltstone, limestone, and conglomerate: Light-gray calcareous siltstone and fine-grained sandstone with thin beds and lenses of silty limestone; includes some reefal limestone at Marble Pond and elsewhere, and coarser grained sandstone and conglomerate in the northwest corner of the Shin Pond quadrangle. Fossils, especially brachiopods, corals, and stromatoporoids locally abundant. Some assemblages dated as Early or Late Silurian (late Llandovery or Wenlock) age; others are more certainly Late Silurian (Wenlock or early Ludlow) age. Probable minimum thickness, 500 feet.

Upper Silurian sedimentary and mafic volcanic rocks (apparently the thickened volcanic equivalent of the calcareous siltstone sequence described above): Massive metamorphosed mafic volcanic rocks including pyroclastics, interfingered and interbedded with green tuffaceous slate and siltstone, conglomerate with red and green matrix, and muddy sandstone; also minor amounts of reefal limestone, some with basaltic clasts. Scattered fossils in green tuffaceous slate, green matrix conglomerate, reefal limestone and debris derived therefrom; some assemblages dated as Late Silurian (lower Ludlow), others no more precisely than Silurian or Devonian. Some pre-Silurian rocks may be included. Thickness several thousand feet.

Devonian or Silurian mafic volcanic rocks: Tuff, breccia with scoriaceous fragments, and probably some flows. Possibly the same as Upper Silurian volcanic unit, but lacks fossils.

Seboomook Formation (Boucot, 1961, p. 169): Graded beds of fine-grained, crossbedded sandstone, dark-gray siltstone, and slate, and a few thick beds of finegrained feldspathic sandstone like that of the Matagamon Sandstone. One exposure of gray sandy siltstone at the base contains a few Lower Devonian brachiopods. Thickness variable: 4,000 feet on East Branch of the Penobscot.

Matagamon Sandstone (Rankin, 1965): Thick-bedded, fine- to medium-grained feldspathic sandstone and subordinate amounts of siltstone and slate like that of the Seboomook. Sandstone commonly well laminated and crossbedded; some displays scour-and-fill structure. Load casts of sandstone in siltstone ("pseudonodules") rare. The Matagamon is a sandstone facies of the Seboomook. Fossils scarce except in occasional shell beds where Lower Devonian (Becraft-Oriskany) brachiopods are abundant. Thickness: 4,000 to 5,000 feet.

Quartz latite of Traveler Mountain (The name "Traveler Rhyolite" is generally attributed to "Toppan, 1932," an unpublished Master's thesis at Union College, Schenectady, New York; inasmuch as this thesis cannot be considered a publication and the rock is now considered to be a quartz latite, the unit remains without a formal name.): Dark dense aphanitic quartz latite that breaks with a conchoidol fracture and contains a few percent of small (1 to 3 mm) phenocrysts. Lava, ash-flow tuff, airfall tuff, and breccia have been recognized. Little sedimentary rock is interbedded, and no fossils have been recognized. The quartz latite must be younger than the Matagamon Sandstone which is of Becraft-Oriskany age and older than the Trout Valley Formation of Early or Middle Devonian age. It is the youngest stratigraphic unit intruded by the quartz monzonite of Mt. Katahdin. The quartz latite is described in more detail in a separate section of this guidebook.

Trout Valley Formation of Dorf and Rankin (1962) : Light blue-gray to black shale, siltstone, sandstone and conglomerate, and minor amounts of sideritic sandstone and black sideritic ironstone. A massive conglomerate lentil, probably a deltaic deposit, occurs at the base along South Branch Ponds Brook—the route traversed by Field Trip AS_1. Although pebble and granule conglomerate is scattered throughout, conglomerate lenses are less common in the upper part; boulder and cobble conglomerate is largely restricted to the basal conglomerate lentil. No rock fragments other than felsite have been observed in the conglomerate.

Fossils include plants (in some places so abundant that the rock resembles a low-grade coal), ostracodes, estherids(?) and eurypterid scales. Well-preserved impressions of terrestrial plants were characterized by Dorf and Rankin (1962) as a *Psilophyton* flora and interpreted by them to indicate an Early Devonian (Onesquethaw-late Coblenzian) age; however, they may be somewhat younger (Schopf, 1964, p. D49). The relatively undeformed condition of the Trout Valley may be due to its post-tectonic age if it proves to be equivalent to the post-Acadian Middle Devonian Mapleton Sandstone of Aroostook County; on the other hand it may be due to its shielded tectonic position above the thick competent quartz latite of Traveler Mountain. Exposed thickness about 1,500 feet.

SOUTHEAST FLANK OF ANTICLINORIUM

Silurian sandstone and conglomerate with minor slate: Feldspathic sandstone, polymict pebble and cobble conglomerate, and gray slate and siltstone. The coarser conglomerate, containing cobbles of porphyritic quartz diorite, greenstone, quartzite, and other rocks, occurs in the fault slices of the southeast flank of the anticlinorium; at one place interbedded sandstone yielded Lower Silurian (upper Llandovery) fossils. Pebble conglomerate and sandstone without dateable fossils lies in the core of an anticline to the southeast. Sandstone with subordinate conglomerate, like the Frenchville Formation in the Presque Isle quadrangle (Boucot and others, 1964), and also with Lower Silurian fossils, lies in the core of a second anticline still farther southeast in the Stacyville quadrangle. Estimated minimum thickness, 5,000 feet.

Silurian slate, siltstone, and minor sandstone: Medium- to dark-gray, greenish-gray, and red slate and siltstone, and a few beds of fine- to medium-grained sandstone. Monograptid graptolites rare, including late Llandovery to early Ludlow forms. Estimated thickness, about 10,000 feet.

INTRUSIVE ROCKS

Ordovician metadiabase: Gray and greenish-gray, fine- to coarse-grained metadiabase forming massive ledges. Occurs as a sill above Shin Brook Formation.

Silurian or Ordovician porphyritic quartz diorite: Fine- to coarse-grained, gray to greenish-gray, sheared and altered porphyritic quartz diorite and granodiorite, characterized by phenocrysts of quartz and feldspar as much as half an inch in cross section. Potassic feldspar, some slightly perthitic, constitutes as much as one-third of the feldspar. Total feldspar somewhat more abundant than quartz. Chlorite and epidote pseudomorphic after biotite; calcite abundant in patches and veinlets. Locally contains abundant large xenoliths of greenstone and quartzite.

Devonian granophyre: Light-gray granophyre containing about 5 percent phenocrysts of quartz, plagioclase, and biotite. Plagioclase phenocrysts commonly in rosettes 2 to 3 mm in diameter. Groundmass granophyric or spherulitic.

Devonian (post-tectonic) quartz monzonite of Mount Katahdin (= "Katahdin Granite" of authors): Granoblastic phase is massive medium-gray, medium-grained, and consists of two-thirds feldspar (about three-fifths perthite and two-fifths zoned plagioclase), one-third quartz, and 5 to 10 percent biotite. Where altered, potassic feldspar is pink, plagioclase is greenish, and chlorite replaces biotite. The quartz monzonite is porphyritic locally, and contains pink-weathering perthite phenocrysts 5 mm long in a groundmass somewhat finer grained than the granoblastic phase. The granophyric phase is vuggy, pink, and contains phenocrysts of biotite. Vugs contain epidote, tourmaline, quartz, and potassic feldspar. Border phase on the east is fine grained and contains abundant fragments of thermally altered and partially assimilated sedimentary rocks.

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ROAD LOG, TRIP AF

THE ANTICLINORIUM CORE, AND THE SILURIAN AND DEVONIAN ROCKS ON ITS NORTHWEST FLANK

By Robert B. Neuman, Leader

Topographic quadrangle maps:

15-minute	2-degree
Shin Pond	Presque Isle

Assemble in front of Shin Pond House, Shin Pond, Maine ready for departure at 8:00 A.M., Friday, September 30. Road limitations dictate that private cars be used. Please insure that (1) each car carries at least 4 people, (2) at the start the fuel tank of each car is full, and (3) the spare tire is inflated and useable. Most stops will be off the road, examining sections in the woods along streams. It will be in the best interests of all participants to keep the group as compact as possible. When the leader decides adequate time has elapsed for examination of the exposures, he will return to the cars and proceed to the next stop. Therefore, keep alert to the movements of the group, and do not risk being left in the woods like Hansel and Gretel. There are no gingerbread houses here.

Mileage

0.0 Shin Pond House, facing northwest.

0.3 Roadside ledges are thin-bedded, crossbedded quartzite of the Grand Pitch Formation and porphyritic quartz diorite.

0.4 Roadside ledges are medium- and dark-gray slate and quartzite of the Grand Pitch Formation.

0.5 Very light colored and fine-grained phase of the porphyritic quartz diorite, and Grand Pitch slate.

0.9 T5R7 town line.

1.3 Wild Land Grocery; T6R6 town line.

1.5 T6R7 town line.

1.6 Road on right to Snowshoe and Whitehorse Lakes.

1.9 View of Sugarloaf Mountain straight ahead. The mountain is capped by a metadiabase sill enclosed in a syncline plunging northeast. Beneath the sill, on the slopes of the mountain is the Shin Brook Formation. The best fossils to come from the Shin Brook were found on the easily climbed southern slope at 1,500 feet altitude.

2.6 Spring and lunchgrounds.

2.7 STOP 1. SHIN BROOK FORMATION: (fig. 3) Walk down old road to left about 1,300 feet to small clearing, then straight ahead through the bushes to the bank of Shin Brook at an old bridge abutment. At this point, and for about 50 feet to the north, the Grand Pitch Formation is exposed in the streambank. Here it consists of medium- to dark-gray slate, and thin-bedded, laminated, fine-grained, light-gray quartzite. With a little search some crossbedded quartzite can be found. Note the tight, steeply plunging folds.

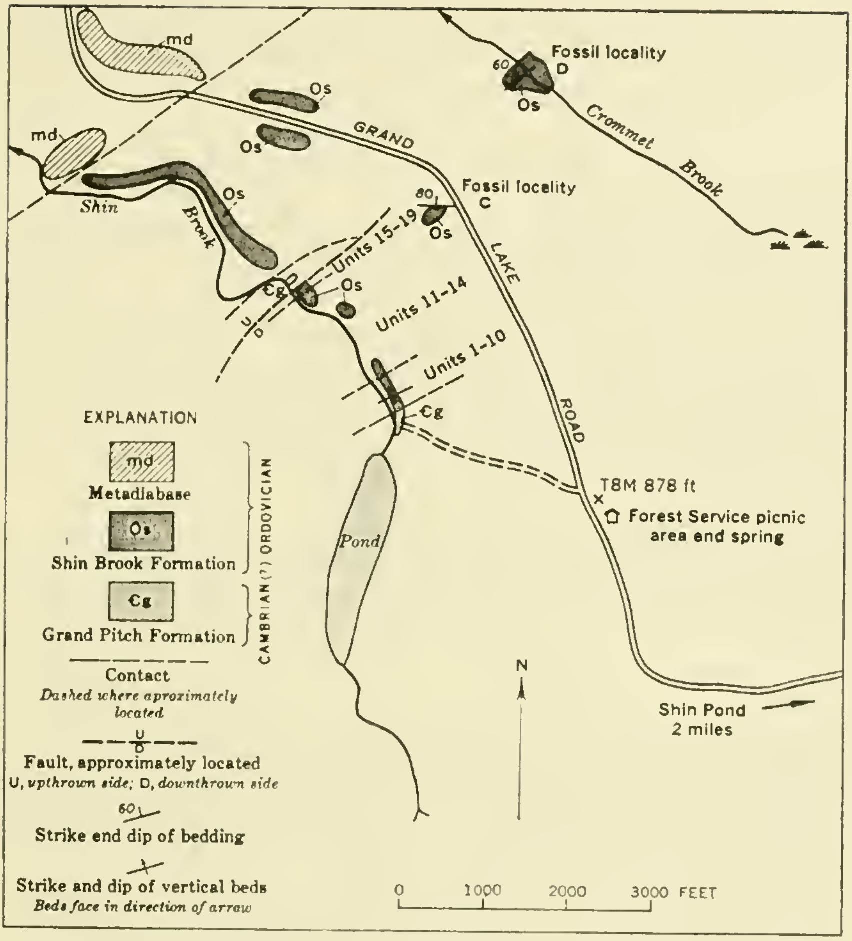

Figure 3. Geologic sketch map of the vicinity of the type section of the Shin Brook Formation; units 1-19 described in text. Patterned areas indicate outcrops

The base of the Shin Brook Formation is just above a spotted slate which is about 2 feet thick. The section measured here (reproduced from U. S. Geol. Survey Bull. 1181-E, p. E-6) consists of:

	Thickness (feet)
Shin Brook Formation: (907 ft. measured of which 304 ft. is exposed)	
19. Tuffaceous sandstone and siltstone in graded layers 3-12 in. thick; with coarse-grained sandstone in the basal part and finely laminated siltstone at the top; siltstone more abundant than sandstone; unit includes two layers of crystal tuff, 6 in. and 2 ft. thick, respectively	35
18. Crystal tuff, greenish-gray; crystals are green altered plagioclase	10
17. Covered	3
16. Tuffaceous sandstone, grit, and conglomerate; finer grained part is well laminated, coarser part not laminated and includes fragments of porphyritic and nonporphyritic fine-grained igneous rock; ledge in streambed has distorted bedding structures that suggest deformation prior to lithification; base concealed	7
15. Tuffaceous sandstone, fine- to medium-grained, calcareous; strongly sheared with weathered pits that may have been concentrations of fragmental fossils; fossils, largely brachiopods, too strongly deformed to be identified	18
14. Covered	70

13.	Crystal tuff, greenish-gray; with scattered angular cognate rock fragments ½-6 in. in average diameter; crystals of both matrix and fragments are green altered plagioclase; no primary layering seen; quartz veins abundant	20
12.	Covered	375
11.	Crystal tuff; light-green altered plagioclase phenocrysts in a darker aphanitic matrix; fractured	45
10.	Covered	95
9.	Tuff, fine-grained, light-greenish-gray; abundant carbonate; strongly sheared, with no bedding structures preserved	30
8.	Covered	30
7.	Volcanic conglomerate, with granules of aphanitic volcanic rock and dark slate, strongly sheared; bedding obliterated	50
6.	Tuffaceous sandstone, gray, medium- and fine-grained; abundant carbonate; bedding obliterated by strong shearing	20
5.	Covered	30
4.	Volcanic granule conglomerate and coarse-grained sandstone, light-gray, strongly sheared	25
3.	Sandstone and conglomerate, interbedded, with conglomerate beds 10-20 in. thick, sandstone somewhat thinner; angular to subrounded fragments as much as 1½ in. in average diameter include volcanic rocks and fine-grained quartzite	35
2.	Phyllite, light-gray, probably tuffaceous	2
1.	Slate, dark-gray, with small (¼-½ mm) white grains (altered plagioclase?) with rhombic outline abundant	2

3.1 Ledges to left of road include fossil locality C of fig. 3 from which large specimens of *Orthambonites robustus* Neuman, deformed *Platystrophia* sp., and bryozoans were collected. Fossil locality D, shell beds of *O. robustus*, is about 1,500 feet to the northeast in Crommet Brook.

3.6 Ledges on left are metadiabase of the sill that overlies the Shin Brook Formation.

4.9 STOP 2. GRAND PITCH FORMATION AT SHIN FALLS: Walk south along old road about 2,500 feet to second small road to left (rushing water is plainly audible at this point). Turn left (to east) and follow this road about 1,200 feet to Shin Brook at bridge (do not cross bridge); then follow Shin Brook westward, downstream.

The first large ledges are greenish-gray, fine-grained quartzite with interbedded gray and red slate. Crossbedding and graded bedding are not as conspicuous as they are in the next exposures downstream.

Exposures at the upper cascades of the falls have somewhat more slate and thinner quartzite layers. Note that from graded bedding and crossbedding, beds face in the same direction for only short distances, and then are abruptly reversed.

Please do not descend waterfalls, but return to road and cars from above log sluice.

5.7 Ledges on left are quartzite of the Grand Pitch Formation.

5.9 Bridge over Seboeis River.

6.7 Road right to Scraggly Lake.

8.6 Roadside ledge of Seboomook Formation.

9.0 Roadside ledge of Seboomook Formation.

10.2 Roadside ledge of Seboomook Formation.

10.5 Forest Service Camp; road right to Hay Lake; glimpse of lake from the highway.

10.7 Turn left onto Bowlin Pond Road (signs point to Chapmans Camps).

12.0 Weathered exposure of Seboomook Formation.

12.5 Roadbed "pavement" exposure of Seboomook Formation.

12.6 Small road right at Smokey-the-Bear sign; reverse direction of caravan by turning into this road and backing down (south) gravel road the full length of the caravan so that all cars can turn.

STOP 3. SILURIAN SEQUENCE: (fig. 4). Walk south along Bowlin Pond Road about 1,200 feet beyond turnaround to overgrown woods road to left (east). Follow woods road about 1,500 feet east and south to clearing and abrupt left turn uphill. In Bowlin Brook about 300 feet south of this clearing is a small waterfall exposing the base of the Silurian sequence. Opposite the falls to the south, and separated from the Silurian rocks by a covever interval about 10 feet wide, is a ledge of red and green slate and siltstone of the Grand Pitch; southward from this ledge for several hundred feet along the brook are nearly continuous exposures of red, green, and gray slate and siltstone, and greenish-gray, fine-grained, laminated, thin-bedded quartzite typical of parts of the Grand Pitch.

In the falls are gray and dark-gray slate and slaty siltstone with thin seams of coarse-grained sandstone. Note the contrast of deformation on opposite sides of the covered interval; also note that in the Silurian rocks in the waterfall the lineation formed by the intersection of cleavage on bedding surfaces plunges to the northeast.

About 50 feet west of the brook are beds of crudely graded quartzose pebble conglomerate and coarse-grained sandstone that are probably covered beneath the waterfalls in the brook. Above the waterfalls are about 30 feet of red slate and siltstone which are in turn overlain by about 50 feet of interbedded conglomerate, sandstone, and siltstone; these conglomerates contain *Pentamerus* and other Silurian brachiopods.

After examining this section return to the Bowlin Pond Road for examination of the remainder of the section.

The following section was measured in the woods west of the road (fig. 4).

Unit

11. Seboomook Formation, including fossiliferous siltstone at the base.
10. Gray, well-bedded calcareous siltstone with widely scattered comminuted organic debris; 85 feet thick.
9. Calcarenite, largely pelmatozoan debris, with stromatoporoids and favositid corals as much as 6 inches in cross section; 50 feet thick.
8. Calcareous siltstone with silty limestone nodules a few inches in diameter irregularly distributed; 25 feet thick.

   Covered interval of 70 feet.
7. Calcareous siltstone, largely massive, but containing a few silty limestone nodules an inch or two in diameter in beds 5 to 10 inches thick separated by fine-grained limestone beds 1 to 2 inches thick, some of which are cut into *boudins* by partitions of siltstone parallel to slaty cleavage; 170 feet thick.

   Covered interval of 70 feet.
6. Calcareous siltstone, faintly laminated, with prominent partings at 2- to 10-inch intervals; scarce, fragmentary brachiopods; 65 feet thick.

   Covered interval of 85 feet.
5. Calcareous siltstone like Unit 6 above; 50 feet thick.

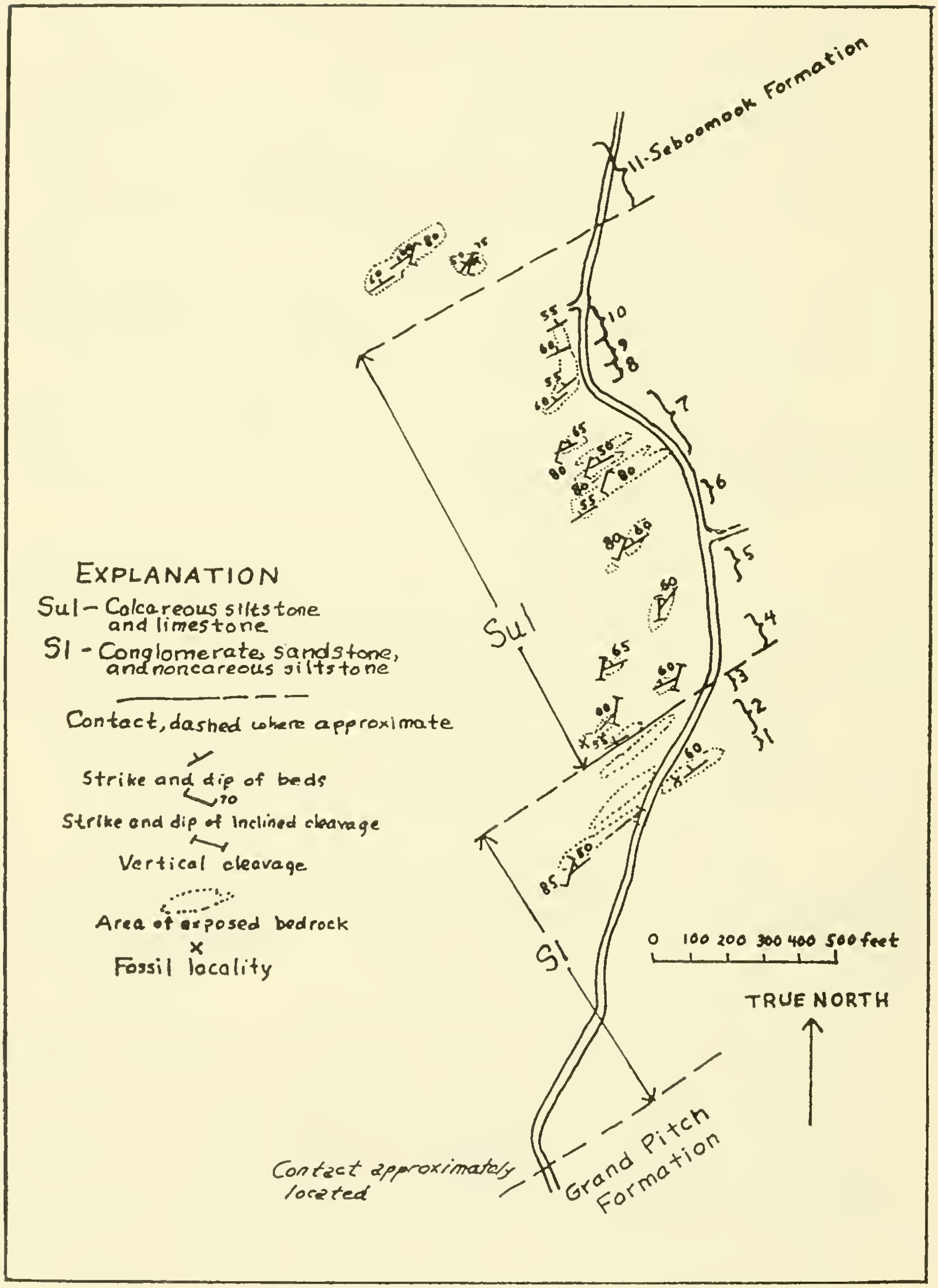

Figure 4. Sketch map showing location of exposures and units of the Silurian sequence along the Bowlin Pond Road, Shin Pond quadrangle

Unit

4. Calcareous fine-grained sandstone and siltstone, mostly in graded beds 4 to 8 inches thick; includes a dark, noncalcareous siltstone bed about 3 feet thick, 10 feet below the top of the unit, that contains abundant, well-preserved brachiopods, trilobites, and corals; 70 feet thick.

3. Pebble and granule conglomerate, sandstone and siltstone, all calcareous, in well-defined graded beds 4 to 8 inches thick; contains fragments of brachiopods and corals; 45 feet thick.

   Covered interval of 35 feet.

2. Conglomerate with rounded pebbles and granules, mostly of quartz, but felsitic volcanic rock, quartzite, and tabular fragments of slate and siltstone also common; beds poorly defined, about 4 feet thick; scattered brachiopods, tabulate and rugose corals; 65 feet thick.

   Covered interval of 25 feet.

1. Noncalcareous, greenish-gray siltstone and fine-grained sandstone and thin granule conglomerate (exposed in the bed of the Bowlin Pond Road); 5 feet exposed.

   Estimated thickness of unexposed beds to the Grand Pitch Formation contact: 575 feet.

Return to Grand Lake Road

Mileage

14.5 Turn right onto Grand Lake Road.

18.5 Turn left onto Scraggly Lake Road.

20.0 Bridge over Sawtelle Brook.

STOP 4. SEBOOMOOK FORMATION AT SAWTELLE FALLS: Ledge on the north bank of Sawtelle Brook is fine-grained sandstone identical to that of the Matagamon Sandstone, one of several that occur throughout the Seboomook.

Walk eastward along old road and trail about 2,000 feet to falls.

The falls afford an especially informative exposure of the Seboomook Formation as large areas of bedding surface are visible. The ripplemarked fine-grained sandstone is especially interesting, as it reveals in plan view what is seen as small-scale crossbedding at the base of graded sets in cross section. Note the regular orientation of the ripplemarks and the relation of their elongation to the intersection of bedding and cleavage.

The plunge pool and its downstream extension follows the trough of a syncline, the beds on the opposite side of the stream dipping steeply northwest. This is the only fold in the area that has a horizontal axis.

Return to cars and to the Shin Pond House. If time permits, the first 2 or 3 stops of Trip AS_2 will be added to the itinerary.

ROAD LOG, TRIP AS_2

THE SOUTHEAST FLANK OF THE ANTICLINORIUM

By Robert B. Neuman, Leader

Topographic quadrangle maps:

15-minute	2-degree
Shin Pond	Millinocket
Island Falls	
Sherman	
Stacyville	

Assemble in front of Shin Pond House, Shin Pond, Maine, ready for departure at 8:00 A.M., Saturday, October 1. Admonitions of the Friday trip apply to this one as well.

Mileage

0.0 Shin Pond House, facing south.

0.2 Thoroughfare between Upper and Lower Shin Ponds.

0.4 STOP 1. Roadside ledge on right is breccia consisting of fragments of greenstone and Grand Pitch quartzite which are xenoliths in porphyritic quartz diorite.

0.7 Roadside ledge on left is especially coarse-grained porphyritic quartz diorite that contains a few greenstone xenoliths.

2.1 Roadside ledge on left opposite cabin is Silurian conglomerate containing flattened and elongated pebbles; elongation is vertical.

2.8 STOP 2. "The Last Resort." Ledges in the field on the west side of the road, south of the farmhouse include cobble conglomerate containing fragments of porphyritic quartz diorite, mafic and felsic volcanic rocks, and quartzite. The rock here is considerably more deformed than it is farther southwest in this fault block, but this is the most accessible exposure.

3.3 STOP 3. Roadside ledge on right contains southeast-facing sets of graded, coarse-grained sandstone and slate representative of the lower, coarse-grained part of the Silurian sequence on the southeast flank of the anticlinorium. Note refracted cleavage and lineation formed by the intersection of bedding and cleavage.

3.4 Allsbury Road; turn left.

4.1 STOP 4. Valley of Peasley Brook. At or immediately beneath the roadbed on both sides of the brook are exposures of sandstone, siltstone, and slate that will be the type section of a formation to be named after this road in the report on the Island Falls quadrangle by Ekren and Frischknecht. Because the road is alternately gravelled and washed out, it is impossible to determine in advance which part of the sequence will be available for inspection. Parts of the section are predominantly gray sandstone and siltstone with minor amounts of dark-gray slate, and other parts are largely dark-gray sulfidic slate. The latter are conductive to small electrical currents and were distinguished electromagnetically by Ekren and Frischknecht. Such rock contains graptolites in a few places where bedding and cleavage are parallel.

7.0 Ledges on right are dark sulfidic slate.

8.1 Maine Highway 11; turn right.

11.3 Ledge on right is black sulfidic slate; on left in field is sandstone and conglomerate.

12.4 Entering Patten; go straight through town on Maine 11.

13.3 Fish Stream. About ½ mile upstream (west) is black slate that has yielded the most abundant monograptid graptolites from this part of the sequence.

13.7 Leaving Patten.

16.2 Happy Corners Road; keep straight on Maine 11.

17.2 STOP 5. Hilltop with hotdog stand and view. To the west, valley of the East Branch of the Penobscot River, Mt. Katahdin, and Traveler Mountain. The near wooded ridge is supported by the lower sandy part of the Silurian sequence, and in the middle ground are the bare ledges of Ordovician volcanic rocks on Lunksoos Mountain.

21.6 Bangor and Aroostook Railroad at Sherman Station.

23.8 Roadcut on right is gray slate and thin-bedded, fine-grained limestone, probably a part of the Silurian succession, but the Sherman quadrangle has not been mapped.

24.5 Turn right following Maine 11.

25.8 Roadcuts to left are tightly folded gray slate and siltstone.

26.2 A few trace fossils (nereitids) from these exposures are like those associated with Silurian graptolites at Waterville to the southwest, and at Dyer Brook to the northeast and thus suggest the Silurian age of these rocks.

27.1 Siberia; Bangor and Aroostook Railroad.

30.1 Stacyville Post Office.

30.6 Route 11 turns sharp left; go straight ahead on unpaved road.

31.1 Swift Brook; sawmill.

35.6 Road forks; go left. Right fork goes to the site of Hunt Farm where 130 years ago Charles T. Jackson was lodged.

38.4 STOP 6. East Branch of the Penobscot River at Whetstone Falls. Rock is gray slate and thin-bedded fine-grained sandstone assigned to the same formation as that examined at Allsbury Road. Note the steeply plunging folds; note also that the thickness of sandstone layers and offset along cleavage surfaces are proportional; dislocations of the thicker sandstones are greater than those of the thinner ones and barely visible in laminated slate. This is the western edge of the belt of fine-grained Silurian rocks; the western boundary is thought to be a strike-slip fault whose trace is buried beneath the alluvium in the East Branch.
Cross river on bridge.

38.7 Turn right.

39.9 Bridge over Sandbank Stream.

42.1 STOP 7. Ordovician chert at bridge over Wassataquoik Stream (fig. 5). The ledges along the south bank of the stream both east and west of the bridge are thin-bedded gray and green chert with thin partings of siliceous slate; these rocks are included in a formation to be named after this stream. Graptolites were first collected here by Dodge in 1881, and later by E. S. C. Smith. We have found only fragmentary specimens here, and they occur in the slaty partings. In addition, a slate layer about 200 feet downstream from the bridge has yielded conodonts.

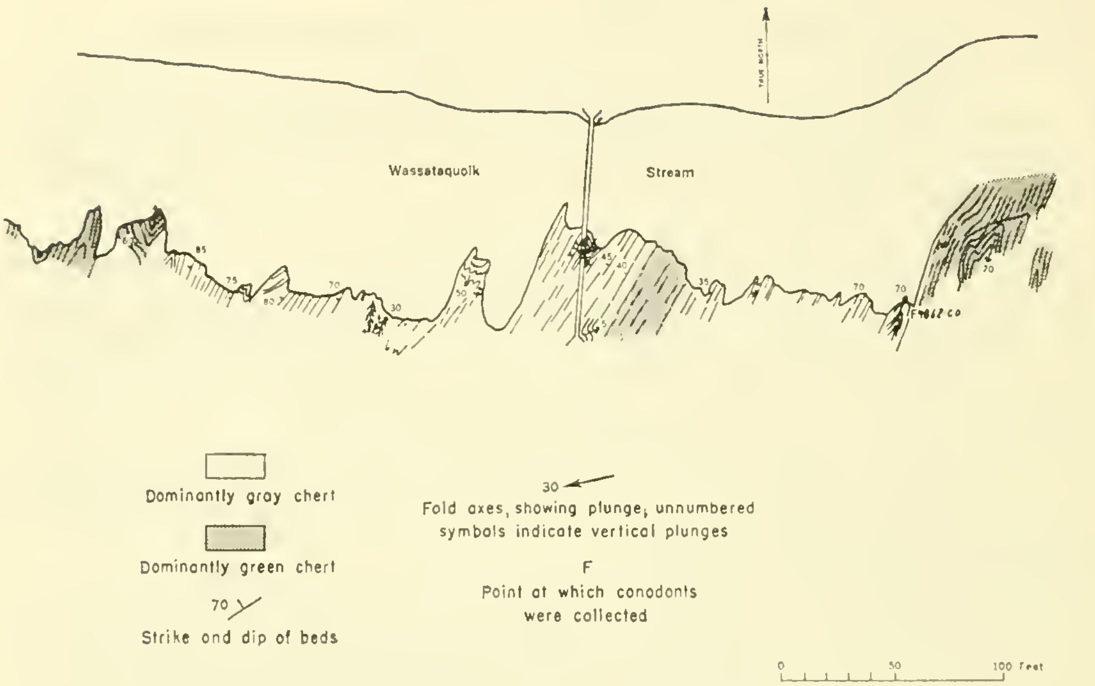

Figure 5. Sketch map of the exposures of Ordovician chert at the bridge over Wassataquoik Stream about one mile northwest of its mouth, Stacyville quadrangle

The beds are thrown into intricate, steeply plunging folds. Because these rocks contain no positive top criteria, the stratigraphic succession within the exposure remains equivocal. From relations elsewhere it seems likely that the chert overlies the unit of mafic volcanic rocks (greenstone) such as that at Stop 9.

Cross bridge and continue northward along this road (approximately the Telos Tote Road of the topographic map).

44.3 Bridge over Owen Brook; cross bridge and turn into first woods road on right

STOP 8. Upper Silurian high-calcium limestone. Follow logging road about 2,000 feet to third road branching right (east), then about 1,000 feet to ledges. Several kinds of limestone are present, including some that is medium to light gray and fine grained, some light-gray calcarenite, and some that is breccia in which red staining is conspicuous. Stromatoporoids, colonial and rugose corals are common, and the large brachiopod *Conchidium* has been collected here. Both the corals and the brachiopod indicate that the limestone is of Late Silurian (early Ludlow) age.

Bedding is obscure in most places, but where seen it strikes northwest. The limestone is strongly fractured or cleaved. The rocks surrounding the limestone are of several different kinds; thus the limestone is considered to be a fault block, a part of the fault complex on the southeast flank of the anticlinorium.

Until about 20 years ago erratics derived from this limestone stimulated prospecting as far south as Wassataquoik Stream, but the ledges themselves were not found until we came across them in the course of geologic mapping in 1963. Limestone is an essential ingredient in the older pulp-making process, and for many years the Great Northern Paper Company brought it to Millinocket from Union, 125 miles away. The modernized plant, 12 miles from here, no longer uses limestone, but the deposit may have potential for other chemical, agricultural, and construction uses.

Turn around and return to junction just west of Whetstone Falls.

49.9 Turn right (west); road approximately follows Sandbank Trail of topographic map.

50.2 Bridge over Sandbank Stream.

52.5 Road forks; keep right (road left goes to Millinocket).

52.9 Road forks; keep right.

55.2 STOP 9. Ordovician mafic volcanic rocks (greenstone) at big bend of Wassataquoik Stream. Please do not go beyond the waterside ledges just below the bend.

Although the origin of the Ordovician greenstones is obscure at most places, here and at a few other places it is plainly a pillow lava. Pillows range from 1 to 3 feet in average diameter; their rounded surfaces are weathered out throughout these exposures, and cross sections of them can be seen along the river bank. In section, their central parts are coarser grained than their margins, and they are outlined by green, epidote-rich selvages. Some are concentrated in vertically standing layers and are defined by stratified rock—either tuff or reworked weathering products. Downward-facing necks are present but rare; tops have been determined from them and other features. Perhaps the field trip participants will confirm our conclusions on this.

Turn around and return to last major road forks.

57.5 Road junction; turn right.

58.5 STOP 10. Turn out at crest of hill where road turns right. Border breccia of the quartz monzonite of Mount Katahdin. The large drift boulders by the roadside are good samples of this rock, affording 3-dimensional views of its structures without moss cover. To reach ledges, go about 750 feet north of turn in road to first rise, then right (east) into the woods 900 feet to top of hill, 1,020 feet. Xenoliths include thin-bedded metaquartzite, "gneiss" or "granulite" containing abundant biotite and reflecting original graded bedding. Xenoliths are folded; some have abrupt boundaries with enclosing fine-grained granitic matrix, and these commonly have pronounced reaction rims. Other boundaries are vague, indicating that the xenoliths are partly assimilated into the matrix.

The attitude of the xenoliths seems chaotic, as strikes and dips in all directions can be found; most dips, however, are gentle.

There are no accessible exposures of the granoblastic phase of the quartz monzonite in this area. The many large drift boulders are excellent samples of this rock, and it is exposed at the top of Wassataquoik Mountain, ½ mile to the northwest.

RETURN TO SHIN POND FOR BARBECUE AT MOUNT CHASE LODGE

QUARTZ LATITE OF TRAVELER MOUNTAIN[1]

By Douglas W. Rankin

The quartz latite of Traveler Mountain is the northeasternmost and by far the largest of a discontinuous belt of equivalent Lower Devonian felsic volcanic rocks in northern Maine (Boucot and others, 1964). It is of interest because of its size, its situation in a geosynclinal environment, and its interpreted volcanic history.

The quartz latite occupies a structurally depressed, roughly quadrilateral area on the northwest limb of the Weeksboro-Lunksoos Lake Anticline. It is bounded by high-angle faults on its north and west sides and intruded by the quartz monzonite of Mt. Katahdin on its south side. The present outcrop area of the quartz latite within this structural depression measures about 8 by 12 miles, and its maximum thickness is at least 10,000 feet. Taking the average thickness to be 5,000 feet, the volume of quartz latite within the structural depression is on the order of 80 cubic miles. It is, therefore, one of the largest bodies of felsite in the United States, if not the world. The depression is thought to be an ancient caldera.

Because interbedded sediments are rare and because no soil zones have been observed between any units, the quartz latite was probably erupted in a relatively short time. As ash flow sheets constitute a large part of the unit, most of it was probably erupted subaerially (Rankin, 1960).

In the field, the quartz latite is a monotonously homogeneous unit. The origin of some of the rocks, such as thinly bedded air-fall tuff, is obvious in outcrop, but, in general, thin sections are required to distinguish between rock types. Many rocks are sufficiently recrystallized so that even thin sections are of little help. Thus, although it is known that a certain outcrop consists of welded tuff, the extent of that particular ash-flow sheet, either laterally or vertically, is not known.

By a combination of field and petrographic studies, the quartz latite of Traveler Mountain has been divided into the two members (fig. 1 of Neuman and Rankin, this guidebook). A particular type of volcanic activity appears to have produced the bulk of each member. The percentage of quartz phenocrysts is the only consistent difference observable in the field between the two members. The significance of the quartz phenocryst content was recognized after completion of most of the fieldwork. Limited field checking has shown that the subdivision is a valid one; the contact between the two members is gradational in terms of the percentage of quartz phenocrysts present. It is, however, extremely difficult with a hand lens to recognize small quartz phenocrysts that constitute 5 percent or less of the rock. Over much of its length, the contact between the members is approximated between locations from which hand specimens were collected.

The lower member of the quartz latite is characterized by ash-flow tuffs containing quartz, plagioclase, and altered mafic phenocrysts. Typically, the member contains 15 percent phenocrysts, of which about one-third are quartz.

The upper member is characterized by lava containing plagioclase, clinopyroxene, and, in some rocks, biotite phenocrysts. Quartz phenocrysts are absent or sparse. Typically the lava contains 10 percent phenocrysts of which about 75 percent are plagioclase, 20 percent are clinopyroxene (and biotite) and 5 percent are magnetite. Growth aggregates of phenocrysts, rare in the ash-flow tuff of the lower member, are common in the lava of the upper member.

[1] Publication authorized by the director, U. S. Geological Survey

Plagioclase phenocrysts in both members are zoned and have average bulk composition of calcic andesine. Sanidine phenocrysts are rare, having been observed in only a few samples of ash-flow tuff from the lower member. The clinopyroxene is ferroaugite. Although garnet is characteristic of some northern Maine felsites of similar age, it has been observed at only a few localities in both members of the quartz latite of Traveler Mountain.

There are only four existing chemical analyses of the quartz latite—about one per 20 cubic miles of rock. The silica content of the analyzed rocks ranges from 71.42 to 74.39. In the classification of Rittmann (1952) they are "rhyolite" and "dark soda rhyolite." The name quartz latite has been used in preference because the chemically similar plutonic rock of Mt. Katahdin is a quartz monzonite in the modal classification of Batemen and others (1963).

Sampling is not adequate to deduce any systematic compositional variation. However, the four analyses (two from each member) are similar, as are the norms. The normative constituents plot in the vicinity of the minimum melting compositions in the steam-saturated system SiO_2-$KAlSi_3O_8$-$NaAlSi_3O_8$. The analyses that do exist, and the uniform appearance of the rocks suggest that there is little compositional variation either within each member or between members. Compositional uniformity within each member is also suggested by the uniformity of phenocryst content.

To recapitulate, the felsite of Traveler Mountain is a large mass of rather homogeneous quartz latite. It consists of a lower member of ash-flow tuffs containing quartz and plagioclase phenocrysts and an upper member of lavas containing plagioclase phenocrysts. The above relationship may be interpreted by reference to the synthetic granite system, $NaAlSi_3O_8$-$KAlSi_3O_8$-SiO_2-H_2O. Tuttle and Bowen (1958) show that at the liquidus a decrease in water content (decrease in steam saturation pressure) shifts the quartz-feldspar field boundary toward the SiO_2 corner of the SiO_2-Or-Ab diagram. That is, a liquid in equilibrium with feldspar crystals at a higher steam saturation pressure might be in equilibrium with quartz and feldspar crystals at a lower steam saturation pressure with no other change in composition.

The presence of phenocrysts in the quartz latite of Traveler Mountain indicates that the magma was at the liquidus at the time of eruption. Several workers have pointed out that early violent eruptions of felsic ash flows are commonly followed by quieter eruptions of felsic lava flows, and that the most reasonable explanation for this phenomenon is an exhaustion of volatile constituents which are the driving force of volcanism. Kennedy (1955) suggested that at equilibrium the water content of a magma should decrease downward in the magma chamber. The quartz latite of Traveler Mountain may represent essentially an inverted magma chamber, the lowest rocks representing the upper part of the chamber. Thus the lower ash-flow sheets containing quartz and feldspar phenocrysts may have been erupted from "wetter," cooler liquids in the upper part of the magma chamber. The lavas containing feldspar phenocrysts may have been erupted from "drier," hotter liquids deeper in the magma chamber.

ROAD LOG, TRIP AS_1

DEVONIAN VOLCANIC AND SEDIMENTARY ROCKS ON THE NORTHWEST FLANK OF THE WEEKSBORO-LUNKSOOS LAKE ANTICLINE

By Douglas W. Rankin, Leader

Topographic quadrangle maps

15-minute	2-degree
Shin Pond	Presque Isle
Traveler Mountain	

Assemble in front of Shin Pond House, Shin Pond, Maine, ready for departure at 8:00 A.M., Saturday, October 1. Bob Neuman's cautionary words for the Friday trip should be heeded. In addition, this trip includes a 200-foot climb over a steep, rough, trailless slope and a 3-mile walk down a stream. Stout walking shoes are essential. Wet feet are guaranteed.

Mileage

0.0 Shin Pond House, facing northwest. Retrace route of trip AF as far as Bowlin Pond Road.

5.9 Bridge over Seboeis River.

7.1 Beginning of long straight stretch of road with view down road of North Traveler and Bald Mountains underlain by quartz latite.

10.4 Side road right to Hay Lake.

10.7 Side road left to Bowlin Pond.

11.1 T5R8 town line. Gradational contact between Seboomook Formation and Matagamon Sandstone crosses road near here.

11.8 Roadside ledges of Matagamon Sandstone, as are all roadside ledges as far as the shore of Grand Lake Matagamon.

13.1 STOP 1. Overlook and exposures of Matagamon Sandstone. In good weather there is a fine view here of the mountains to the west. To the southwest, Mt. Katahdin is visible between Turner Mountain on the left and Traveler Mountain on the right. The long mass of Traveler Mountain is across the valley of the East Branch. Although The Traveler is only 3,541 feet high, it rises 3,000 feet above the river. The bare conical peak of Bald Mountain is set against North Traveler Mountain. The last mountain to the right, barely visible from here, is Horse Mountain on the shore of Grand Lake Matagamon. In 1861, C. H. Hitchcock referred to this as the mountain with the inelegant name. Turner and Katahdin are composed of quartz monzonite, the rest of quartz latite.

The Matagamon Sandstone here is in a northeast-trending structural basin, the Hay Mountain Basin (Rankin, 1965). These exposures are very nearly on the axis of the basin, and the sandstone dips gently northeast.

14.7 Bridge over East Branch of the Penobscot River, a favorite for white-water canoeists. H. D. Thoreau (1950) extolled the joys of the East Branch after his 1857 trip down it. Road right on west side of bridge leads 0.5 mile upriver to Grand Lake Dam at foot of Grand Lake Matagamon. Good exposures of Matagamon Sandstone form east abutment of dam.

15.7 Baxter State Park Boundary. Largest state park in Maine with an area of nearly 200,000 acres. Six hundred-foot cliffs of quartz latite forming Horse Mountain on left.

15.9 STOP 2. Park as close to the edge of the road as you can. Climb about 200 feet up steep slope to the base of cliffs. Be extremely careful in crossing scree slope. Remember there are others behind you. The lower member of the quartz latite forms the cliffs above. The Matagamon Sandstone underlies the scree slope over which we climb. The contact, defined as the sharp change in lithology from underlying obviously stratified rocks to massive quartz latite above, is more or less exposed at the top of the scree slope and dips 20° to the west. The top 20 feet or so of the Matagamon contain scattered pebbles of felsite and beds of tuffaceous sandstone, indicating that some volcanic activity preceded the massive felsite.

The basal 2 or 4 feet of the massive quartz latite are composed of nonwelded tuff in which devitrified shards are clearly visible (fig. 6). This grades up into welded ash-flow tuff that appears to make up most of the quartz latite of the Horse Mountain cliffs. Fragments of collapsed pumice are visible in the quartz latite a few feet above the base. Deformed and flattened shards are visible in a thin section collected from this locality 5 feet above the base. Columnar joints, another characteristic of ash-flow tuffs, may be seen in the cliff face. These are most obvious in the main part of the cliff to the south and are perhaps most easily seen from the road. Some are as much as 4 feet in diameter and at least 40 feet long.

If one traces the contact along the base of the cliffs it is seen to be an irregular surface with relief up to 15 or 20 feet. This irregularity may be due to scouring by ash flows.

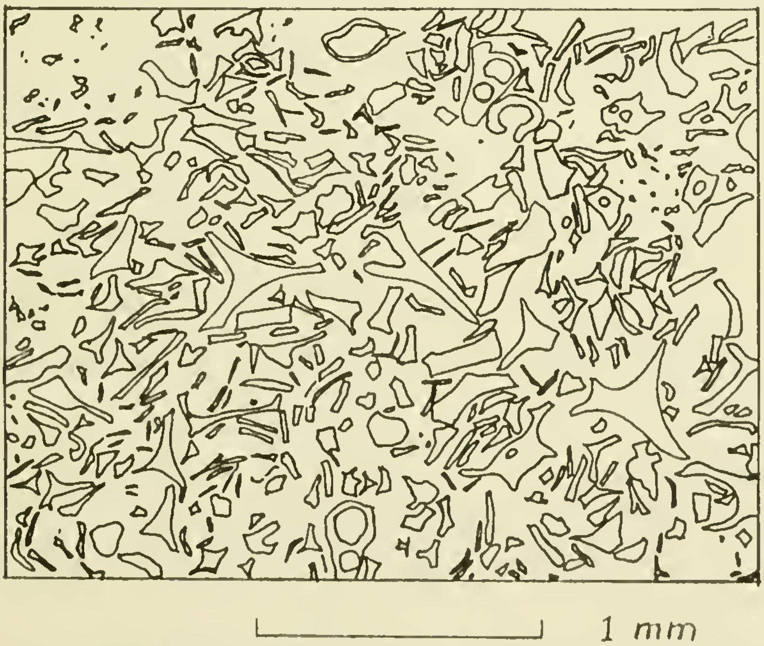

Figure 6. Tracing of photomicrograph of nonwelded tuff from base of lower member of quartz latite on Horse Mountain

16.3 STOP 3. Campsite on right opposite Maine Forest Service Camp. Known locally as Eastern Landing. Walk 0.1 mile ahead (north) along road. Road-cut in lower member of quartz latite showing thin anastomosing dikes of sandstone from the underlying Matagamon Sandstone. Thicker clastic dikes have been found at the base of the cliffs on Horse Mountain and on the shore of Grand Lake Matagamon just ahead of us on the point. The largest clastic dike is about 20 feet thick and at least several tens of feet long (as viewed from the bottom of the cliff).

16.8 Road turns left away from lake and crosses ledges of quartz latite (lower member).

17.9 Cross unexposed, high-angle fault between quartz latite and Seboomook Formation.

19.0 Trout Brook Farm, first cleared in 1837. Produced hay for horses used in logging operations. C. H. Hitchock stayed here in 1861. Rough side road, right, passes through farm and continues to Webster Brook at the head of Grand Lake Matagamon, crossing enroute, some well-exposed open folds in the Seboomook Formation.

19.5 Trout Brook on right parallel to road.

20.0 Sharp turn left. Ledges of Seboomook Formation in woods to left. Excellent exposures of the Seboomook Formation just upstream from the adjacent right-angle turn of Trout Brook. Graded bedding, refracted cleavage, and numerous small folds are featured.

20.2 Parking area left for trail to the delightful lakes of the Deadwater Mountains.

20.5 STOP 4. Park along main road and walk 0.1 mile along side road to site of old K.P. wooden dam on Trout Brook. The dam is built on ledges of brecciated quartz latite. The high-angle fault bounding the quartz latite on the north crosses the stream just below the dam. A thin wedge (30 to 40 feet) of much fractured Matagamon Sandstone lies north of the fault. Beyond this is the Seboomook Formation.

22.9 Crossing of Dry Brook. Spectacular columnar jointing in quartz latite about a mile upstream.

23.4 The Crossing. STOP. Leave appropriate number of cars so that drivers may later be ferried to South Branch Ponds to retrieve remaining cars. This will necessitate considerable doubling up, but it is a short drive and no one wants to walk both ways. After leaving some cars, proceed up side road left to South Branch Ponds Campground.

25.6 STOP 5. South Branch Ponds Campground. Park cars in parking area at entrance to campground and walk to shore of pond for lunch. After lunch we will leave the cars here and walk down South Branch Ponds Brook to The Crossing. There is no trail, the distance is nearly 3 miles, and it is practically impossible to make the trip with dry feet. Please stay with the group. We must leave the campground by 1:30 P.M. and we must all be at The Crossing no later than 4:00 P.M. The sketch map is traced from an aerial photograph, so the scale is approximate. The log of the walk is by numbered stations on the map (fig. 7), not distance.

South Branch Ponds Brook Wade.

1. Shore of Lower South Branch Pond.

South Branch Ponds occupy a glacial valley breaching a large anticline in the upper member of the quartz latite of Traveler Mountain. On Black Cat Mountain to the west (right, looking up the lake away from the campground) flows strike northeast and dip moderately northwest. On Traveler Mountain to the east (left), flows strike northwest and dip moderately northeast. The attitude of these flows controls the northwest pattern of ridges on Traveler Mountain.
Neither the summit of The Traveler nor North Traveler is visible from the lakeshore. Mt. Katahdin is visible over an end of the Upper Pond from the ridge north of the campground.
Retrace route out of campground past parking area and along road toward The Crossing.

2. Reassemble on road at top of long hill (about 0.6 mile from shore of lake). Turn left down slope through open woods. South Branch Ponds Brook is reached in about 0.2 mile. Turn right and walk downstream.

3. Exposures of upper member of the quartz latite of Traveler Mountain. Note pattern of concentric joints in outcrop on corner at stream level. Actually there is more than one center about which joints are concentric, giving rise to a pattern of intersecting curving joints. Well-developed columnar joints of small diameter occur above the stream on east bank. Above this and slightly downstream is another flow unit with columnar joints of larger diameter. Note the foliation in this unit brought out by the presence of very thin lenticular bodies (lenticules).

4. First of a series of joint surfaces across which the stream flows. Close examination will show that these are dip surfaces of flows. Banding (foliation) is roughly parallel to the surfaces, and in places rather crude columnar joints are roughly perpendicular to the surfaces. The flows strike about N. 70° E. and dip 30° N. Local areas of crosscutting breccia are also present in this outcrop on the left bank of stream.

5. Last of the series of dip slopes. Excellent swimming holes at bottom of falls. Banding is visible on a number of steep joint surfaces. Those familiar with felsic volcanic rocks will note the resemblance of the banding in exposures we have seen along the stream to the cutaxitic texture typical of welded tuffs. This is a sticky problem. My conclusion that these are lava flows comes from an accumulation of data from the whole area of quartz latite. Briefly, this particular type of banding made evident on weathered surfaces by the presence of lenticules is characteristic of the upper member and not of the lower member. In thin sections of rocks showing these lenticules, microtextures of lava are common; microtextures of ash-flow tuffs have not been observed. Growth aggregates of phenocrysts are common in these rocks; they have not been found in welded tuffs of the lower member. Photomicrographs are available for inspection.

6. In streambed on east bank just upstream from steep gravel bank at corner. Lowest exposure of conglomerate of the Trout Valley Formation. You, too, might call this a Pleistocene tillite upon first encounter.

7. Jointing cuts cobbles in conglomerate. First clue that this is not a Pleistocene tillite. Some cobbles are offset along the joints. Note that clasts (pebbles, cobbles, and boulders) are well rounded and that all of them are felsite. The

clasts are so weathered that many of them can be broken apart by hand. The weathering may date from the Devonian Period. The conglomerate is crossbedded and dips gently north, away from the volcanic rocks.

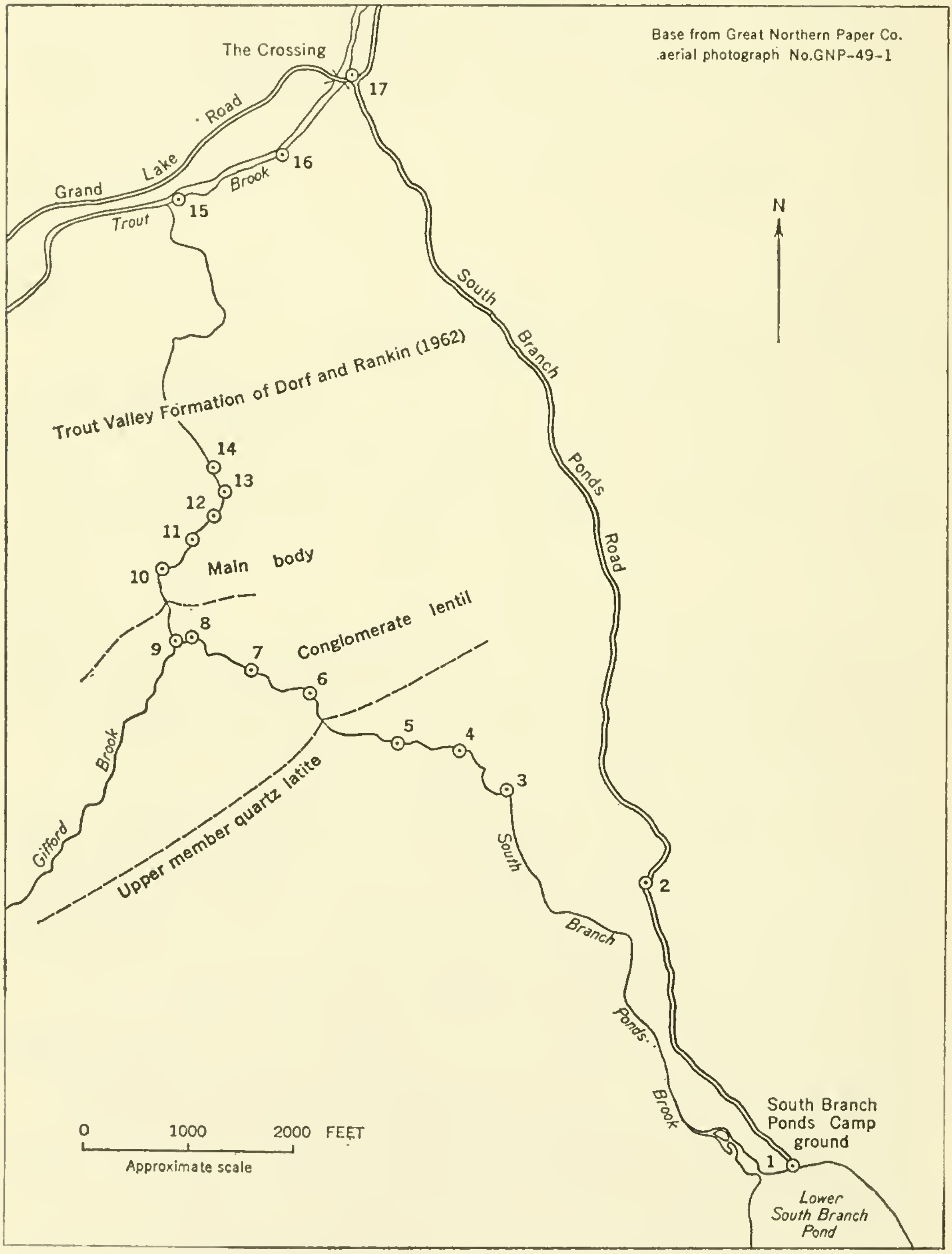

Figure 7. Sketch map of South Branch Ponds Brook

8. About 35 feet of conglomerate exposed in the canyon wall. Where is the contact with the overlying till? Note sandstone bed in the conglomerate near top of exposure and lenses of black sandy carbonaceous shale near bottom.

9. Junction with Gifford Brook.

10. Large exposure at curve of stream on left bank. Coarse conglomerate no longer dominant. We are now above the basal conglomerate lentil and in the main body of the Trout Valley Formation of Dorf and Rankin (1962). Numerous black chert lenses are visible and some have a vague internal structure. Professor E. S. Barghoorn, of Harvard University has identified one of these as *Prototaxites,* which is generally regarded as of algal affinities. Also present are siderite concretions and thin beds of sideritic ironstone.

11. Upstream: sill of intermediate rock and a 6-inch bed of ironstone. Downstream: lens of carbonaceous black shale from which plant fossils were collected in July 1955.

12. Light gray-green fine-grained intermediate dike about 3 feet thick. Trends N. 30° W. and dips 40° N. Note chilled contact against the sedimentary rocks.

13. This is "locality 4" of Dorf and Rankin (1962), from which the best specimens of flattened spiny stems of *Psilophyton* were collected.

14. Gently dipping sill of intermediate rock about 10 feet thick. Plant remains can be found in nearly every outcrop of sedimentary rocks. Reassemble here for half-mile walk out to Trout Brook. It is important to stay together as a group from this point on. If time is running short, we will not follow the stream.

15. Junction of South Branch Ponds Brook and Trout Brook. Turn right (downstream) and follow semi-trail along right (south) bank of Trout Brook.

16. "Locality 1" of Dorf and Rankin (1962). Long outcrop of gently dipping interbedded sandstone and shale of the Trout Valley Formation. Sandstone is calcareous and current bedded. Rather well preserved plant fossils have been recovered from some of the fine-grained sandstones. The erupterid scales also came from this outcrop. A fault of unknown magnitude cuts the southwest end of the exposure.

17. The Crossing. Poorly preserved but large plant fossils occur in the bridge abutment. Drivers will be ferried to South Branch Ponds to recover cars.

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GEOLOGY OF THE RIPOGENUS LAKE AREA, MAINE[1]

Leader: Andrew Griscom

The Ripogenus Lake area is located on the northeast limb of a major northwest-trending anticline which is structurally unique in northern Maine (Boucot, Griscom, and Allingham, 1964) because its axis strikes normal to the regional Appalachian trends. The oldest rocks in the center of the anticline are interbedded sandstones and slates of possible Cambrian age and were tightly folded in Cambro-Ordovician time. They were intruded after the folding by mafic dikes and by a gabbro pluton associated with a limited area of mafic volcanic rocks. All of the mafic igneous rocks may be of Ordovician age and the gabbro is Ordovician as determined by a K-Ar age of 464 m.y. (Faul and others, 1963). Lying with profound unconformity upon these older rocks are fossiliferous Lower Silurian rocks (Willard, 1945; Boucot, 1954; Boucot and others, 1964), well exposed in the vicinity of Ripogenus Dam, where they are about 700 feet thick. These rocks include quartz sandstone and sandy limestone beds containing abundant calcite cement and interbedded limestone and limestone conglomerate layers. At the base of this calcareous unit is hematite-stained quartz-pebble conglomerate which grades upward into coarse dark-colored sandstone; the maximum combined thickness of both lithologic units is about 30 feet. Overlying the calcareous unit is a thick sequence of andesitic lava flows, well exposed on the hill north of the dam. Three associated sills intrude the calcareous unit at Ripogenus Gorge. Calcite-cemented sandstones similar to the underlying fossiliferous ones are interbedded with the lower flows of the volcanic unit, suggesting that the flows also are of Silurian age.

A brick-red siltstone and shale unit overlies the flows and crops out at Frost Pond two miles north of Ripogenus Dam. The red siltstone and shale grade upward through a stratigraphic distance of about 20 feet into dark-gray slates and subgraywackes which are correlated with the Lower Devonian Seboomook Formation (Boucot, 1961; Boucot and others, 1964). The writer has collected fossils of Early Devonian (Oriskany) age (Boucot, 1959, p. 22) from this formation west of Chesuncook Lake at approximately lat. 46°N.

Northwest of Harrington Lake a unit of coarse massive sandstone overlies the Seboomook Formation but is stratigraphically below the synclinal mass of felsic volcanic rocks at nearby Soubunge Mountain. This sandstone may in part correlate with the Lower Devonian Matagamon Sandstone (Rankin, 1965), which has a similar stratigraphic position at Grand Lake Matagamon, 20 miles to the northeast. The volcanic rocks of Soubunge Mountain are quartz latite lava flows and ash flows which correlate with similar volcanic rocks of Early Devonian age in the Traveler Mountain area (Rankin, 1960).

Tight folding and faulting of early Middle Devonian age (Acadian) have affected all of the Paleozoic sedimentary and volcanic rocks. The major northwest-trending anticline, previously mentioned, was probably formed early in the orogeny because superimposed on this fold are northeast-trending minor folds and a pervasive northeast-trending axial plane cleavage.

Subsequent to the folding was the post-tectonic intrusion of the Katahdin batholith, a biotitic quartz monzonite that clearly transects the structure of the older

[1] Publication authorized by the Director, U. S. Geological Survey.

rocks exposed in Ripogenus Gorge. Five miles downstream from the dam a small elongate stock intrudes the batholite; it is compositionally zoned with hornblende-biotite quartz diorite at the margins, grading inward to biotite granodiorite at the center. The stock has a K-Ar age of 361 m.y. (Faul and others, 1963), which is not significantly different from that of the batholith, 356 m.y.

TRIP BF ROAD LOG

Quadrangle map needed: Harrington Lake

Assembly point: In front of Pray's Cottages, which are about 1,000 feet southeast of Ripogenus Dam in the center of the Harrington Lake quadrangle.

Time: 8:00 A.M., Friday, September 30, 1966

Morning trip. Stops 1-7 shown on Figure 1; Stops 8 and 9 not shown.

Afternoon trip. Stop 10 shown in Figure 2; Stops 11 and 12 not shown.

Most of the morning will be used to examine the magnificent exposures in the vicinity of Ripogenus Dam. This part of the field trip, a total distance of about 2.5 miles, will be on foot. Leave lunches in vehicles.

1. Bend in road 1,000 feet west of the Ripogenus Dam-Millinocket Road Jct. Stop 1—Outcrop on south side of road showing interbedded Cambrian(?) sandstone and shale in fault contact with Ordovician(?) basaltic lava flows. Note brecciation of competent beds, the incompetent shale having flowed around sandstone blocks. The fault is thought to have occurred contemporaneously with the intrusion of a large gabbro pluton whose north end is 1 mile south of this road.
2. Shore of Ripogenus Lake 600 feet north of Stop 1. Stop 2—Fault scarp in Ordovician(?) basalt flows, exposed by erosion of the Cambrian(?) sedimentary rocks from the west side of the fault. Note "dikes" of dark shale and brecciated sandstone, as large as 10 feet wide and 75 feet long, which were injected into the volcanic unit during faulting. Locally, these flows exhibit pillow structure. Relict primary augite, magnetite, and plagioclase can still be seen in many thin-sections of these rocks, but the bulk of the rock has been metamorphosed to greenschist facies mineral assemblages of albite and chlorite plus one of the minerals calcite, epidote, or actinolite. Continue north and then east along shore of lake (note calcite veins) to south end of Ripogenus Dam. About 500 feet east of dam on main road is a dirt road leading north down to the foot of the dam. From the north end of the dirt road walk east 600 feet along broad ridges of volcanic rocks.
3. Stop 3—Unconformity with basal sandstone and conglomerate of Silurian age overlying Ordovician(?) volcanic rocks. Note layer of hematite up to 2 inches thick between the Ordovician(?) and the Silurian rocks. Hematite also occurs in veins and joint cracks at stratigraphic distances of as much as 20 feet below the unconformity and is considered to represent a former weathered zone on the volcanic rocks. In the bushes at the north end of this exposure, a normal fault offsets the unconformity a few feet.
4. Walk northeast down a small gully about 150 feet to the bank of the river. Stop 4—Here a ledge of massive white quartzite (not shown on Figure 1) is a prominent marker bed which can be followed discontinuously for 1½ miles to the northwest along the north side of Ripogenus Lake.

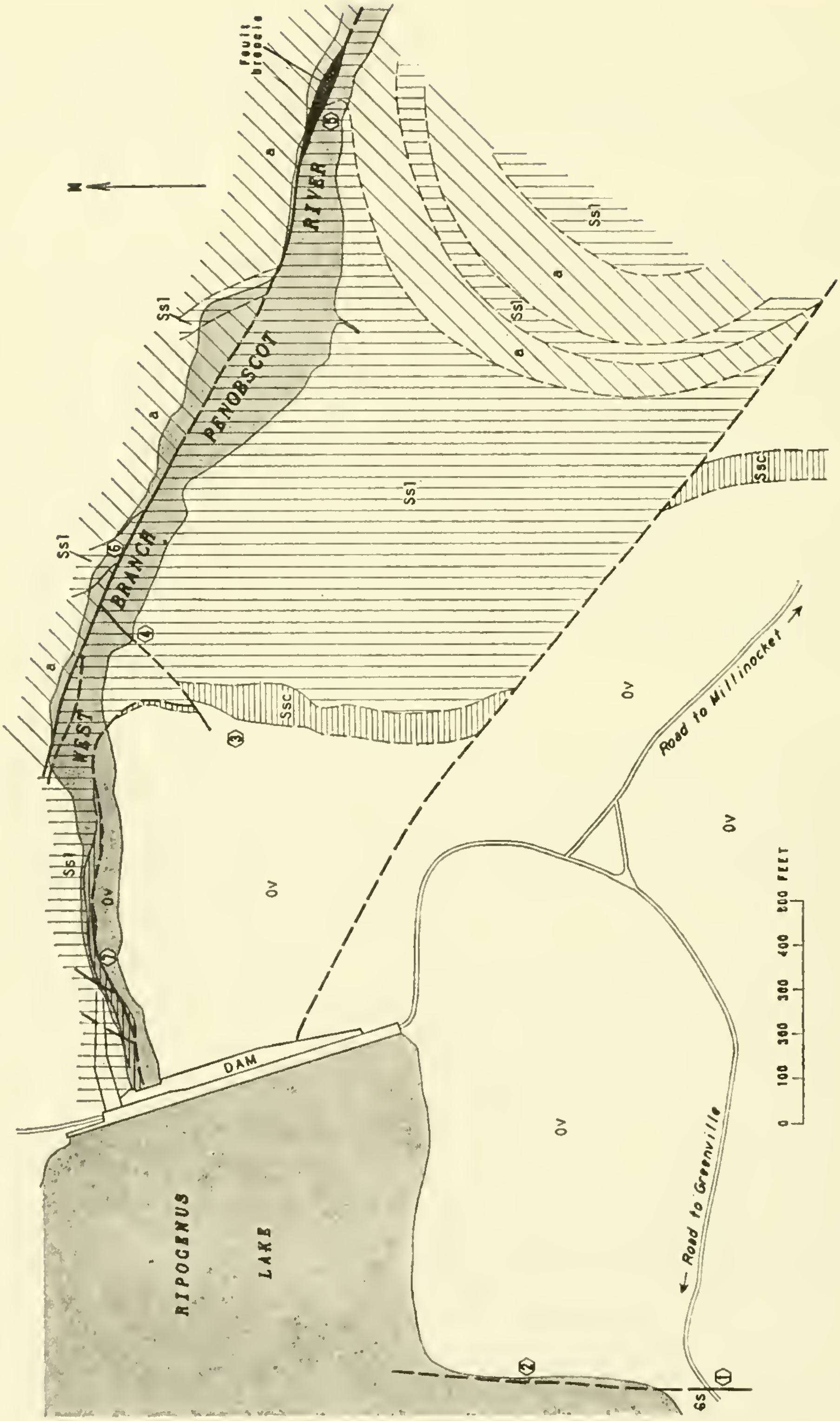
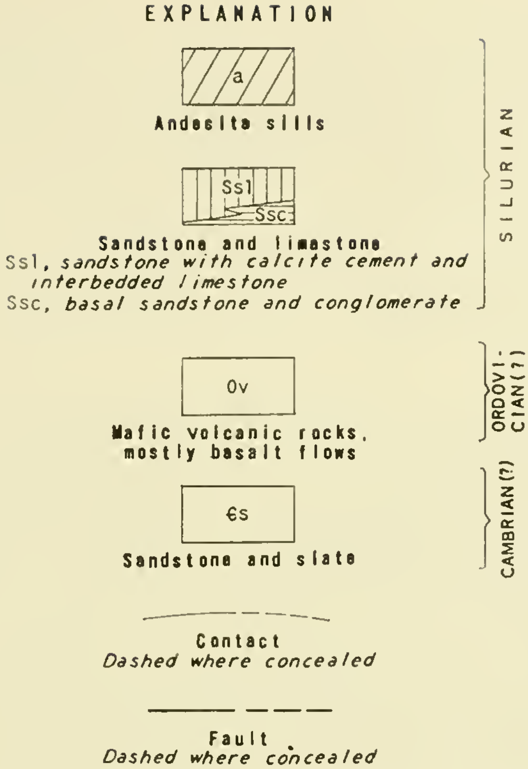


Figure 1. Geologic map of the Ripogenus Dam area, Maine, showing Stops 1 to 7. Base map from Great Northern Paper Co., Bangor, Maine. Explanation on following page.



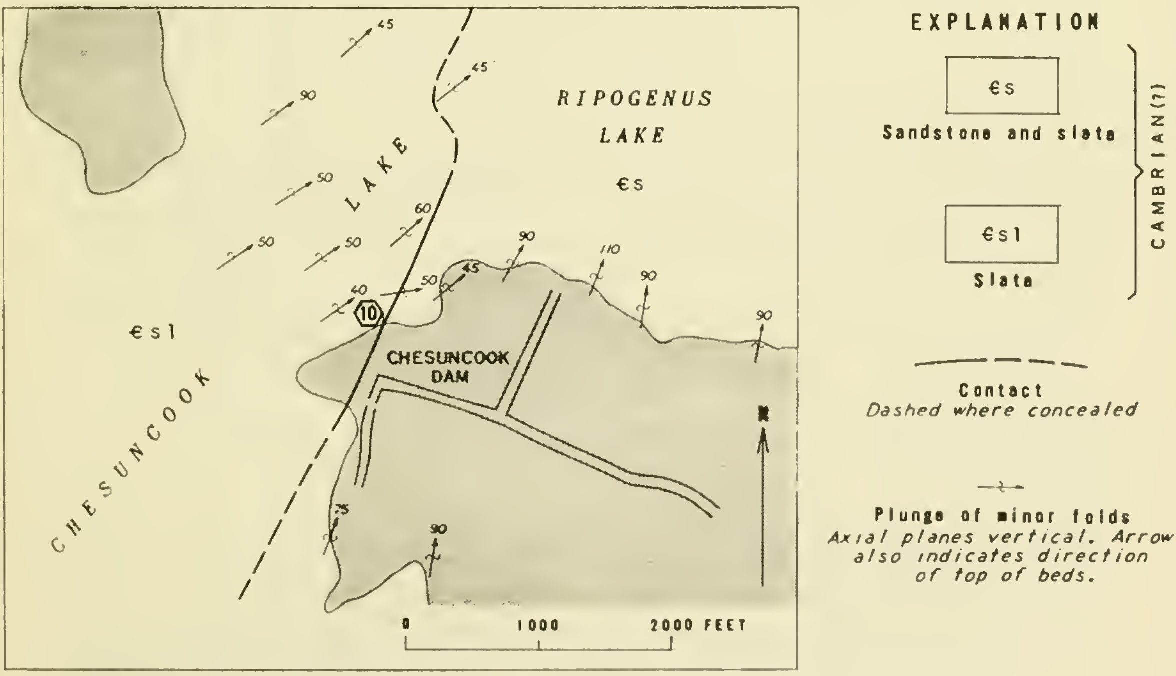


Figure 2. Chesuncook Dam area, Maine. Stop 10. Base modified from Harrington Lake quadrangle map.

5. Continue east along the south bank of the West Branch of the Penobscot River ascending the stratigraphic sequence of this calcareous Silurian unit, which here dips east approximately 20 degrees. A major normal fault follows the north side of the river so that the stratigraphy exposed on the north bank is not continuous across to the south bank. Note increasing metamorphic grade to east, especially the recrystallization of limestone to marble and metamorphism of fine-grained sedimentary rocks to hornfels.

   Stop 5—Andesite sill. Fault breccia in river bottom. If river is high it may be better to return to Stop 4 before crossing to the north bank of the river.

6. Walk west along north bank of West Branch from Stop 5, crossing three sills of andesite.

   Stop 6—The best-exposed sill contacts are at the base of the middle sill and the top of the lower sill, about 150 feet northeast of the quartzite ledge of Stop 4.

7. Continue west about 300 feet until the river gorge becomes narrow and steep walled. Then cross to south bank and walk along the base of the calcareous unit, which here is a bedding-plane fault. At the foot of the dam, Stop 7—examine basal conglomerate and sandstone with associated bedding-plane faults and small branching normal faults striking northeast into the steep cliff of sandstone. The sandstone is pitted with weathered tabulate corals and stromatolids. Many of the rows of pits may be the remains of former continuous beds of limestone which have been subjected to sedimentary boudinage caused by laterally unconfined compaction. Elsewhere tectonic boudinage is common in these rocks where they are tightly folded. The apparent channeling and relief on certain beds are actually manifestations of minor faulting.

8. Climb north up cliff to north end of Ripogenus Dam and walk north on road.

   Stop 8—Large roadcut 200 feet north of dam contains abundant brachiopods and pelecypods. Take it easy with the hammers.

9. Proceed north and then east along road for half a mile until road is only 20 feet from lake shore. Then climb north up talus slope into a prominent gully in face of cliff. BE CAREFUL NOT TO KICK ROCKS DOWN ON PEOPLE BELOW YOU. Stop 9—In the lower 150 feet of the gully are exposed a series of andesite flows interbedded with water-laid tuffs and black shales. A typical flow at its base has a brecciated zone of amygdaloidal andesite grading upward into massive medium-grained diorite. The upper 20 feet of the flows commonly show pillow structures in gradational contact with the massive diorite center.

Return to Assembly Point at Pray's Cottages for lunch. The remaining portion of this field trip will be by automobile.
Mileage log:

0.0 Assembly point. Drive southwest on road toward Greenville.

2.2 Take right turn on side road to Chesuncook Dam.

3.4 Chesuncook Dam. Stop 10 (Figure 2) Numerous exposures of two Cambrian(?) rock units which are tightly folded, the fold axes plunging steeply northeast. Subsequent to the folding a swarm of Ordovician(?) diorite and gabbro dikes intruded the area parallel to the axial planes of the folds. The older of the two rock units is composed of interbedded green and purple slates and tuffs which here are in the chlorite zone of the metamorphic aureole of the gabbro. At Chesuncook Dam most of the formerly purple rocks have been altered to green. The younger unit is characterized by a predominance of massive pale-gray sandstone beds, commonly 1 to 3 feet thick, interbedded with greenish-gray slates and siltstones. Return to assembly point.

6.8 Assembly point. Continue east on road toward Millinocket.

7.4 Pass side road left to Surge Tank of the water tunnel to the powerhouse.

7.6 Take left turn onto side road to powerhouse.

8.0 Powerhouse. Stop 11—Contact of the quartz monzonite of the Katahdin batholith (east) with the Silurian andesitic flow unit (west), here metamorphosed to amphibolite. Contact is a minor fault, branching from the major fault in the river gorge. This major fault is the same as that observed between Stops 4 and 5. Pink color and alteration of the quartz monzonite is a local effect, probably associated with the fault. Joint surfaces of quartz monzonite are coated with druses of pale pink stilbite. Inclusions of amphibolite are common.

Note erratic boulders of metamorphosed black-and-white-layered sedimentary rocks in the parking lot. The dark layers are metamorphosed calcareous quartz siltstones, containing about 80 percent quartz, associated with biotite plus small amounts of diopside, actinolite, microcline, and plagioclase. The light-colored beds are similar except that diopside is more abundant and biotite and microcline are absent. Return to main road to Millinocket.

8.4 Main road from Ripogenus Dam to Millinocket.

Turn left toward Millinocket.

11.7 Road is within a few feet of river which here bends sharply toward the north away from the road and passes over Big Ambejackmockamus Falls. Stop 12—Contact relations between quartz monzonite and the northwest end of a younger elongate stock which here is composed of quartz diorite. Cliffs on river bank at bend north of road contain plutonic breccia of quartz monzonite fragments in quartz diorite matrix. Contact of stock is exposed in outcrops in bushes on south side of road.

End of field trip.

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STRATIGRAPHY AND STRUCTURE OF THE CHAMBERLAIN LAKE REGION, MAINE

Leader: Bradford A. Hall

The Chamberlain Lake area (see Figure 1) occupies a part of the southeast limb of a major northeast trending anticlinorial belt, the Munsungun Anticlinorium of Hall (1964). The structure is cored by rocks of equivocal Cambrian age followed by a thick highly volcanic sequence of Middle Ordovician, Upper Silurian, and Lower Devonian rocks. Most of the Ordovician section lies to the north of the area under consideration in this field trip.

The bedrock of this part of the Munsungun Anticlinorium has been differentiated into eleven mappable units by the author (see Table 1 and Figure 2). Of these, only one, the Seboomook formation, has been referred to a named formation established elsewhere in Maine (Perkins, 1935; Boucot, 1961). The remainder of the units are referred to by rock type. The ages of all but the oldest unit are reasonably well-established on the basis of fossils discovered in the map area. The oldest unit has produced no fossils, and its age is inferred from its stratigraphic and tectonic position and because of the similarity of parts of this unit to parts of the Grand Pitch formation to the southeast, which is considered by Neuman (1962) to be of Cambrian(?) age.

The tectonic history of the area is complex, there being three angular unconformities within the section. In addition, rocks were folded and a regional cleavage and chlorite-grade metamorphism developed during the post-Early Devonian (Becraft-Oriskany) Acadian orogeny. A highly penetrative early foliation or cleavage is also present in the undifferentiated Cambrian(?) rocks but not in rocks of younger age. Post-Middle Ordovician deformation, the Taconic orogeny, and post-Late Silurian deformation, the Salinic disturbance of Boucot (1962), were not intense enough in this area to produce cleavage or metamorphism.

The many fossils collected by the author from rocks of the Munsungun Anticlinorium have been studied by Drs. W. B. N. Berry, A. J. Boucot, R. B. Neuman, W. A. Oliver, Jr., and E. L. Yochelson. Their contributions are gratefully acknowledged.

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TABLE I

ROCK UNITS OF THE
CHAMBERLAIN LAKE REGION

CAMBRIAN(?)

Cambrian undifferentiated (€u).

Red and green, green, or gray phyllite in the southeastern part of the map area. Gray and green phyllite and slate with some siltstone, thin dark limestone interbeds, and blocks of quartz graywacke and calcareous cross-bedded siltstone in the northern part of the map area.

MIDDLE ORDOVICIAN

Mafic volcanic unit (Ovm)

Pillowed basalt, dolerite, siliceous and mafic tuff, slate, and mudstone.

Siliceous volcanic unit (Ovs)

Dolerite; siliceous white-weathering tuff, agglomerate, and slate; varicolored slate and chert.

Undifferentiated volcanics (Ovi)

Mafic tuff, dolerite, and basalt of probable Middle Ordovician age. Some coarser-grained rock of dolerite composition probably intrusive.

UPPER SILURIAN

Volcanic facies (Sv)

Primarily andesitic volcanics; some rhyolitic volcanics.

Conglomerate facies (Scg)

Red, green, and gray lithic conglomerate and sandstone with lenses of conglomeratic, coralline limestone. Red volcanic mud flow on north shore of Arm of Chamberlain Lake.

Calcareous facies (Ss)

Primarily calcareous siltstone and sandstone, sandstone, and impure limestone.

Silurian undifferentiated (Su)

Undifferentiated rocks of the above three Silurian facies.

LOWER DEVONIAN

Calcareous unit (Dls)

Impure silty limestone and calcarenite containing large rounded lithic clasts. This unit is of Helderberg age.

Conglomerate unit (Dcg)

Gray and green lithic conglomerate, red and gray sandstone, and crinoidal calcirudite of Helderberg (probably New Scotland) age.

Sandstone unit (Dss)

Gray calcareous sandstone and siltstone with minor beds and lenses of lithic conglomerate up to about six feet thick. Sandstone beds are commonly from one to six inches thick and cross-bedded. This unit is basal to the Seboomook formation and is probably of Becraft-Oriskany age.

Seboomook formation (Ds)

Laminated two to twelve inch beds of gray siltstone and fine-grained sandstone in the northern part of the map area. Primarily one-half to one inch thick beds of fine-grained sandstone or siltstone and slate in the southern part of the map area. Brachiopods from this unit are of Becraft-Oriskany age.

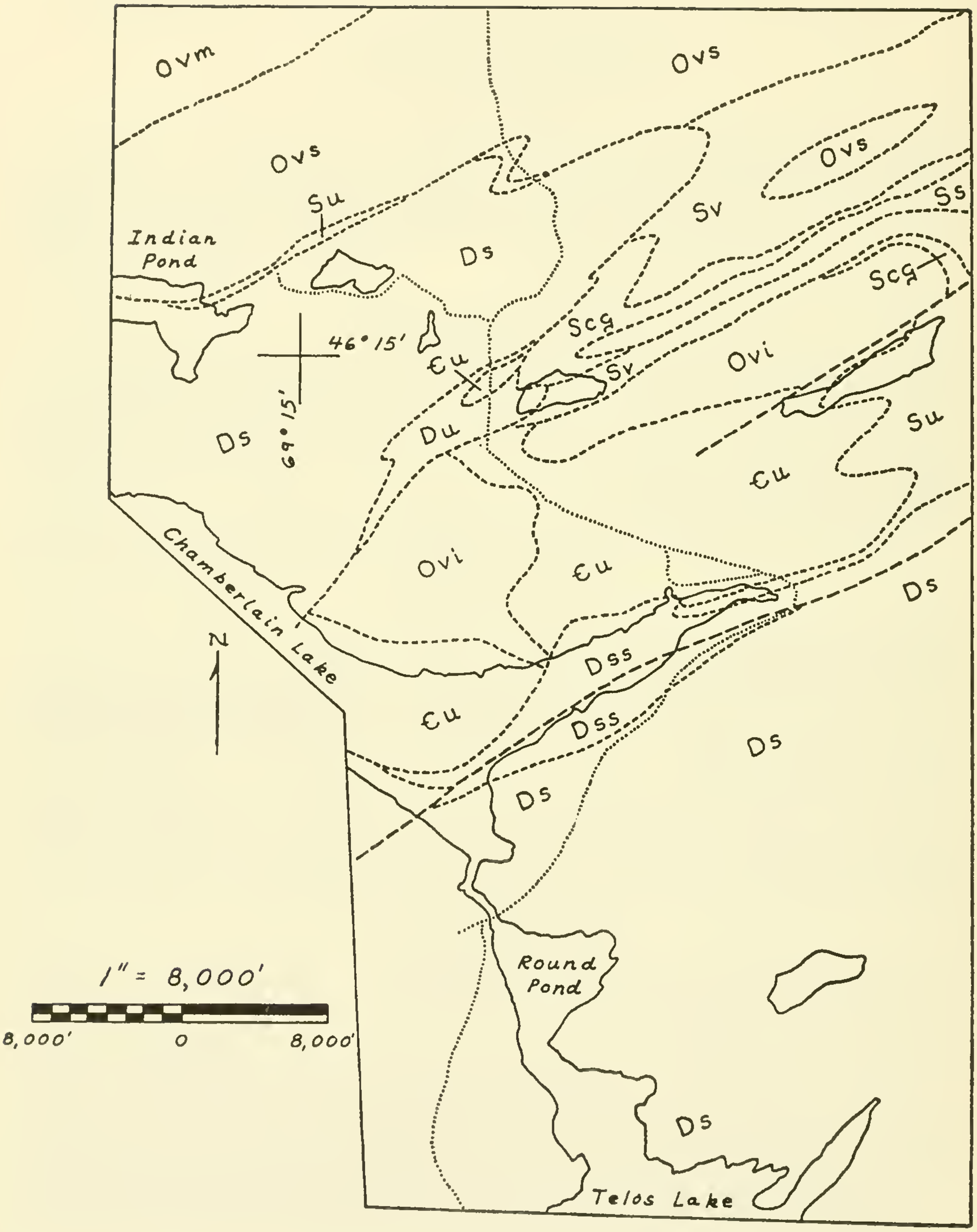


Figure 1. Generalized geologic map of the Chamberlain Lake region. See Figure 2 for legend.

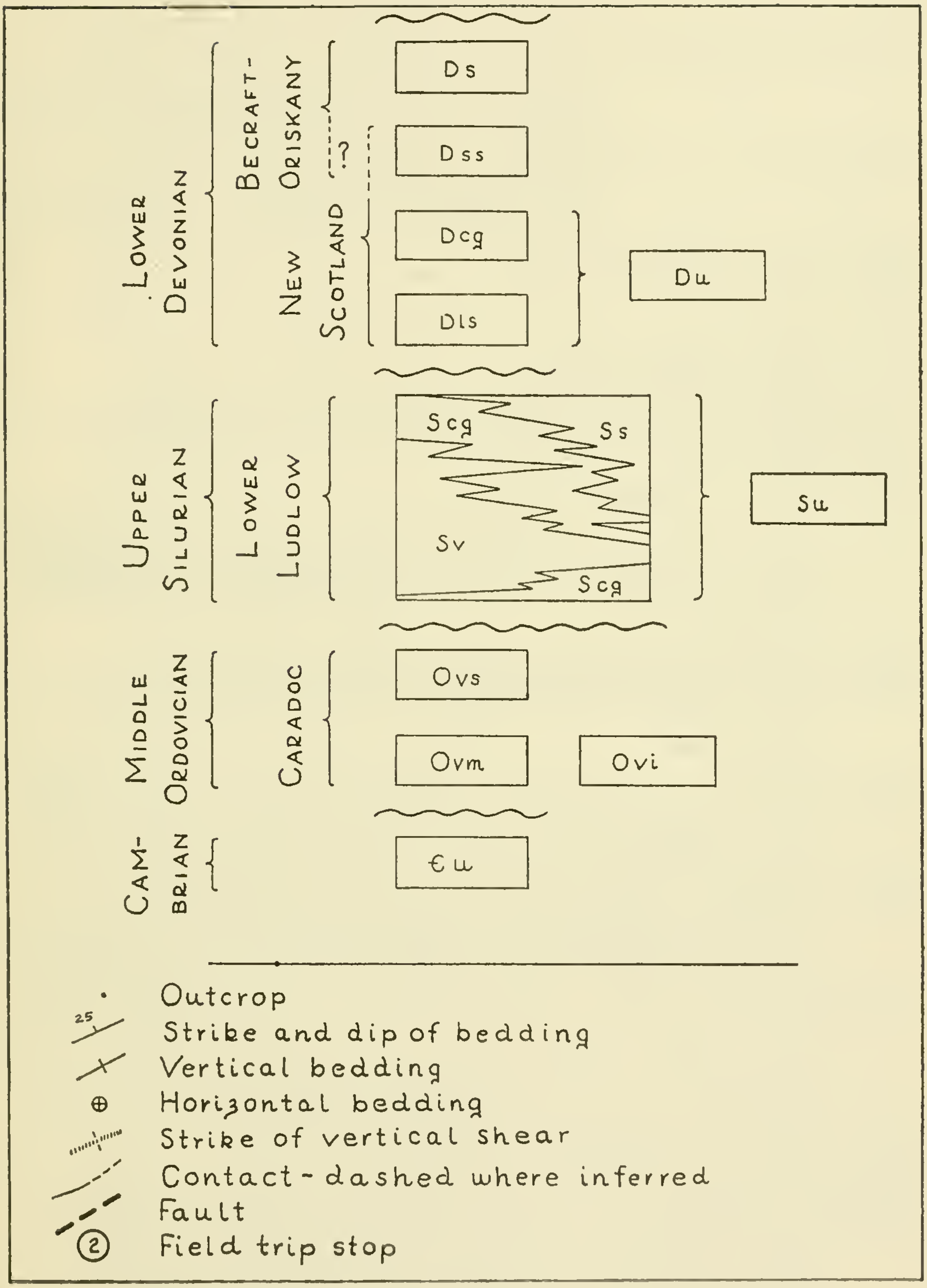


Figure 2. Legend for maps of Figures 1, 3, and 4.
Rock units are described in Table 1.

TRIP BS ROAD LOG

Quadrangle maps needed: Churchill Lake, Spider Lake, Telos Lake, Chesuncook, Harrington Lake. No stops will be made in the latter two quadrangles.

Assembly point: Sourdnahunk Field Campground in northeastern corner of the Harrington Lake quadrangle. Trip will proceed north on Baxter Park road.

Time: 8:00 A.M., October 1, 1966.

Mileage log:

0.0 Assembly point. Sourdnahunk Field Campground.

3.3 Outlet Sourdnahunk Lake.

5.8 Take left turn at fork in road leaving main Baxter Park road.

9.1 Fork in road at North Branch Trout Brook. Bear left toward Thissell Pond.

12.0 Thissell Pond on right through trees.

15.9 Great Northern Paper Company gate approximately one mile south of Telos Lake at 90° right hand turn in road. Proceed straight through gate. The road from this point on is private. Please yield the right of way to all logging vehicles.

22.9 Turn right at lumber camp. Proceed east.

23.1 Center of bridge across thorofare between Round Pond and Chamberlain Lakes. Excellent view to southeast of Mt. Katahdin across Round Pond and Telos Lake.

25.5 Stop #1: Cars may pull off to left side of road as far as possible and park. Proceed on foot north along dirt road approximately 1000 yards to southeast shore of the Arm of Chamberlain. Walk approximately 130 yards northeast along shore to outcrop.

Outcrop of basal sandy unit (Dss) of the Seboomook formation resting with angular unconformity on green and gray Cambrian(?) phyllite (Ꞓu). Slump structure may be seen in the Devonian sandstone unit above a folded angular unconformity. The Devonian unit is here more siliceous than normal, probably due to silicification adjacent to a nearby northeast trending fault. An early pre-Middle Ordovician foliation strikes about N 10° E and dips vertically; this is cut by a later widely spaced Acadian cleavage striking N 50° E with vertical dip. Two sets of glacial grooves are present: one trending N 85° E and a second trending N 65° W.

28.2 Take left turn onto secondary dirt road running parallel to the north side of the Arm of Chamberlain.

29.0 Stop #2: Park cars where convenient on side of road. Outcrop is located on small rise on north side of road.

Red and green or gray highly deformed Cambrian(?) phyllite. The early foliation seen at this stop and at stop #1 locally wraps around late, Acadian folds plunging 27° N 35° E. NO HAMMERS PLEASE.

29.1 Stop #3: Park cars on side of road. Walk southeast approximately 225 yards to abandoned lumber camp. Walk east and southeast approximately 145 yards to point of land between Arm of Chamberlain and east side of cove at mouth of unnamed brook.

Unconformity between red and green Cambrian(?) phyllite and fossiliferous Upper Silurian conglomerate and red mud flow containing abundant angular clasts of Upper Silurian andesitic volcanics.

Stop #4: Return to cars parked for stop #3. Proceed north along road by foot approximately 125 yards to fork in road. Walk approximately 470 yards along left branch of road. Proceed 125 yards to lake shore and east 220 yards to outcrops on point of land between Arm of Chamberlain and west side of cove at mouth of unnamed brook.

Typical basal sandy unit of the Seboomook formation containing conglomerate of cleaved fragments of Cambrian(?) red and green phyllite. This rock overlies the red slump deposits of stop #3 which pinch out in the several hundred feet between stops #3 and #4. Acadian minor folds are well displayed in the red and green Cambrian(?) phyllite at the far end of the outcrop area.

29.5 Rejoin main road. Proceed to northwest.

30.6 Stop #5: Park cars on right side of road. Outcrop in road metal pit on side of road opposite cars.

Outcrop of rusty, medium to dark gray Cambrian(?) slate or phyllite. Early, pre-Middle Ordovician cleavage is nearly horizontal and wrapped around late Acadian folds cut by an axial plane cleavage trending N 5° E and dipping vertically.

31.7 Turn left on secondary dirt road.

33.2 Stop #6: Little Indian Pond on right. Park cars on right side of road. Outcrop on left side of road in face of road metal quarry.

Laminated gray siltstone and fine-grained sandstone (Ds) of Becraft-Oriskany age. Beds range from two inches to twelve inches thick. Coarser-grained materials show some graded bedding and some cross-bedding. This rock is mapped as a facies of the Seboomook formation.

34.1 Stop #7: Park cars in yard of abandoned lumber camp. Walk west on dirt road leaving west side of lumber camp yard. Proceed along road approximately 1500 yards to outcrops on point of land on north shore of east end of Indian Pond.

Angular unconformity between gray Cambrian(?) slate (€u) and massive reef limestone (Ss) of Ludlow age. The unconformity strikes approximately N 70° E and dips about 50° S. Rounded clasts at the base of the Silurian Limestone are from the Middle Ordovician siliceous volcanic unit (Ovs). More angular, cleaved slaty clasts are Cambrian(?). Note the blocks of quartz graywacke on the beach. Blocks of this composition are common in the gray slate of the Cambrian unit (€u).

Return to cars and proceed back to main road via stop #6.

36.5 Turn left on return to main road.

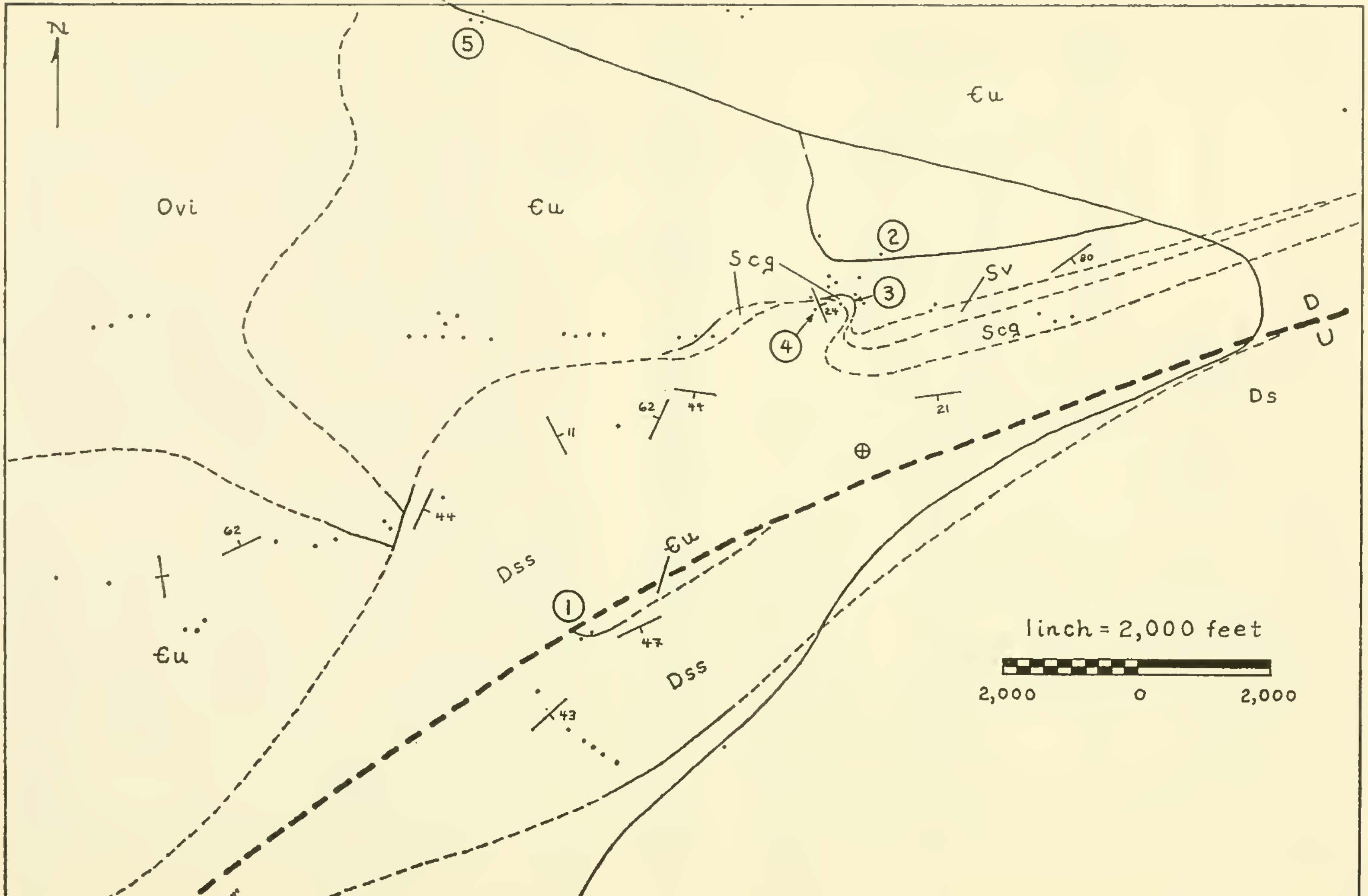


Figure 3. Geologic map of the area including stops 1 through 5. See Figure 2 for legend.

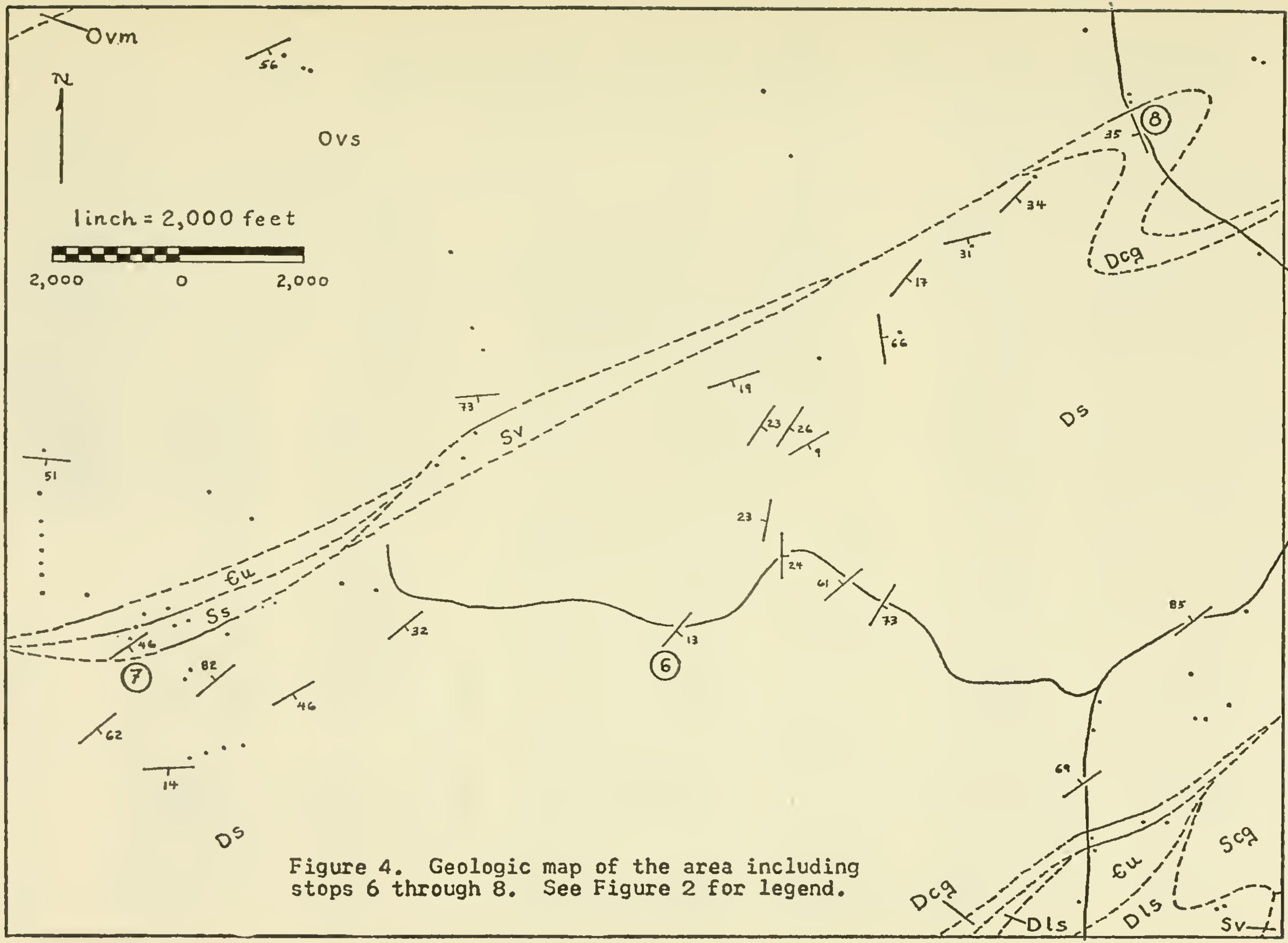


Figure 4. Geologic map of the area including
stops 6 through 8. See Figure 2 for legend.

38.9 Stop #8: Park cars on side of road. Outcrops primarily on right side of road.

Angular unconformity between Middle Ordovician red slate of the siliceous volcanic unit (Ovs) and overlying Lower Devonian rocks (Dcg) of New Scotland age. Immediately above the unconformity is a two to three feet thick rubble zone of fragmented Ordovician red slate and crinoidal debris cemented by manganese oxide. Upward from the rubble zone is green, poorly sorted conglomerate; calcirudite consisting mainly of crinoidal debris and some lithic fragments; red and gray fossiliferous sandstone and conglomerate.

Note the absence in the Ordovician red slate of the early cleavage seen in the Cambrian(?) rocks of stops #1, 2, 4, 5, and 7.

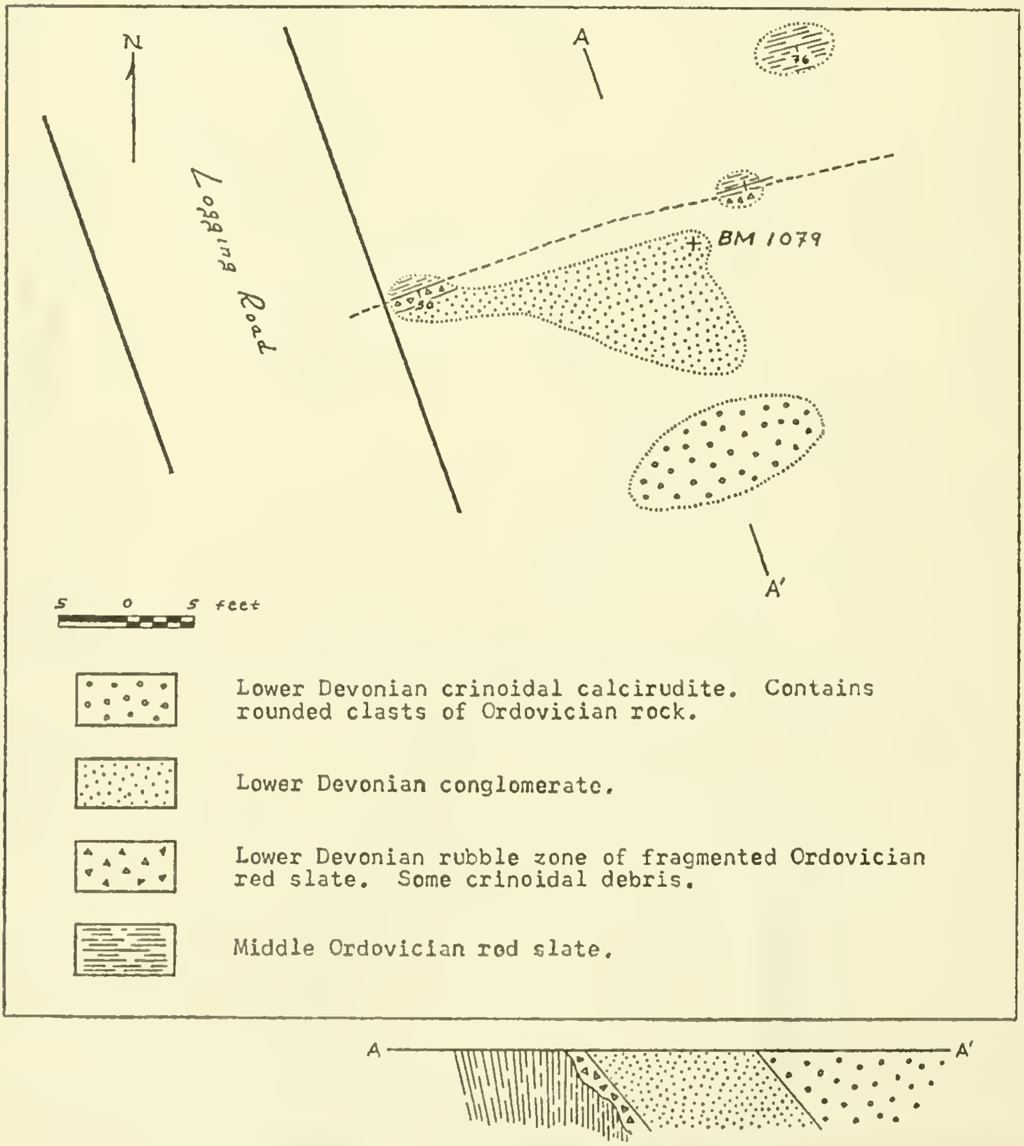


Figure 5. Outcrop map and section at stop 8.

TRIP C—Friday

PLEISTOCENE GEOLOGY OF MT. KATAHDIN

Leader: D. W. Caldwell

The purpose of this trip is to examine the remarkable record of post-continental and late continental glaciation on Mt. Katahdin. This record consists of several well-preserved cirques with prominent end moraines and a lateral moraine deposited by the last continental glacier active in this area.

Mt. Katahdin is the principal topographic feature of this region. Its topographic prominence reflects the differences in resistance to erosion of the granite which underlies Mt. Katahdin and the sedimentary rocks of the surrounding lowlands. A surface of slight relief which characterizes the upper slopes of Mt. Katahdin has been correlated by Goldthwait (1914) with the Presidential Peneplane of the White Mountains. Caldwell (1959) and Thompson (1960, 1961) feel that this surface is the result of glacial erosion, frost action and mass movement, rather than fluvial erosion.

Erratics found by Tarr (1900) and Antevs (1932) near the summit of Baxter Peak and by this writer on other mountains in the region support the accepted view that this region was covered by a continental glacier sometime during the Pleistocene, probably the Wisconsin. It is not certain that the last continental ice in the region covered any of the higher elevations.

The fresh appearance of the cirques and especially of the Knife Edge arete leave no doubt that valley glaciers were active on Mt. Katahdin following continental glaciation. Goldthwait (1939) found no evidence that valley glaciers formed on Mt. Washington in New Hampshire following continental glaciation. Thompson (1960, 1961) feels that post-continental valley glaciers did form on Mt. Washington, but that their record has been removed by mass wasting. As will be discussed later in this report, it is possible that Mt. Washington was the center of a large ice cap at the time when valley glaciers were active on Mt. Katahdin. This might account for the observed differences between the cirques and end moraines on Mt. Katahdin and Mt. Washington.

Road and trail log. Mileage measured from Togue Pond Camps.

Time 7:30 A.M., Friday, September 30, 1966.

0 miles Leave Togue Pond Camps.

- 0.3 Enter Baxter State Park. Road crosses prominent esker.
- 1.0 Rat Pond on left. If day is clear the caravan will stop 10 minutes for photographers.
- 1.8 Rum Brook Campsite.
- 2.4 Esker.
- 5.0 Windey Pitch. Sandy stratified drift and till. Sand-filled ice wedge structures. If JPS and others would like to examine these features, we will stop here on return trip. In pit on north side of Windey Pitch there is coarse shingle gravel with much "rotten-stone" granite. No exposures of bedrock have been found on this and similar ridges which are thought to be end moraines thinly covering bedrock.
- 6.8 Avalanche Brook and Avalanche Field.
- 8.4 Roaring Brook Campsite. Bear left and park in designated area. Secure cars.

Trail log from Roaring Brook Campsite. Approximate mileage and hiking times are given. For part of the climb we will follow an abandoned section of the Chimney Pond trail. Washouts have produced numerous but shallow exposures in the drift. As these exposures change from year to year and as the writer was unable to visit the area this year prior to the preparation of this trail log, there are no designated stops on this part of the trail. However we will stop at any exposure which is of interest to the group.

1.5 miles (45 min.) — STOP 1. This clearing is the result of a forest fire that burned the area in 1923. There are good views of the North Basin Cirque on the right, Great Basin cirque and the Saddle in the middle view and Pamola Peak to the left. Looking north, Traveler Mountain is visible through the broad U-shaped valley of the South Branch of Wassataquoik Stream. Traveler Mountain and its associated peaks are underlain by volcanic rocks. To the east is South Turner Mountain, near the summit of which is a small cirque-like basin. Also to the east and south is the surface of low relief underlain by Paleozoic sedimentary rocks.

To right of trail is a small peat bog dammed by a small moraine. Several bore holes were put down in this bog to obtain samples for pollen analyses. All borings penetrated more than 6 meters of peat, peaty clay or gyttja before refusal at a gravelly clay layer.
The peaty root mat which represents the A_0 soil horizon in much of this region has been removed from parts of the moraine east of the bog. The exposed morainic material consists of grus, cobbles and boulders of granite, some deeply weathered, some fresh and a few scattered erratics. The extensive chemical and mechanical weathering of this and similar exposures is pertinent to a consideration of a possible difference in age between this moraine and the end moraines in cirques at higher elevations. At Blueberry Knoll (stop 3) there will be an opportunity to examine fresher appearing morainic material.

1.9 miles (1 hour) — STOP 2. Basin Ponds.

Basin Ponds are dammed by what this writer (Caldwell, 1959) has called the Basin Pond moraine. This moraine is located in front of three prominent cirques. In all of these cirques the bedrock is granite. Because the Basin Pond moraine is composed of more than 99% granite, it is inferred that the moraine was deposited by glaciers issuing from these cirques. The moraine at Stop 1 contains up to 30% non-granitic material, from which it is inferred that this moraine was deposited by a tongue of a continental glacier. There are certain physical relationships which suggest that the Basin Pond valley glacier moraine and the continental glacier moraine to the east were deposited at the same time. As these relationships are best seen from Blueberry Knoll (stop 3), the various views concerning the possible correlation of these moraines will be aired from that vantage point.

2.3 miles (1 hr. 15 min.) — North Basin Cutoff.

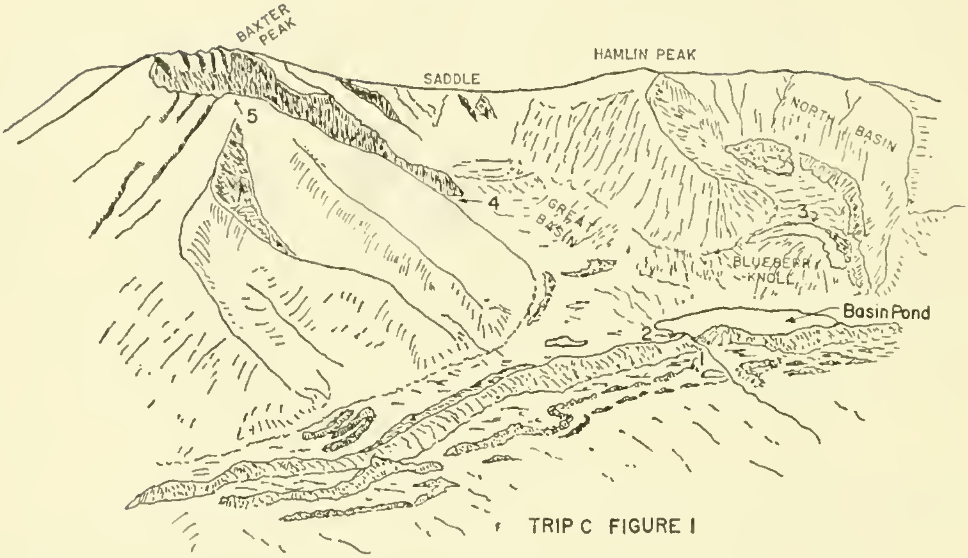
3.0 miles (2 hours) STOP 3. Blueberry Knoll and North Basin cirque.

Blueberry Knoll is at the mouth of what is probably the best developed cirque in New England. As most of the floor of the cirque is above timberline, the morainic topography of the cirque floor is easily visible. About one quarter mile into the cirque are two small small lakes which appear to be dammed by a small, indistinct moraine. From these lakes to the steep headwall, the floor of the cirque has very irregular, hummocky topography. At the very head of the cirque, but separated from the headwall by a depression some 200 feet wide and from 20 to 40 feet deep, is a well defined accumulation of boulders. This feature resembles what Bryan (1934) has called a protalus rampart. Thompson (1961) suggests that it is the ground moraine of a glacier, some of the ice of which may still be buried beneath the bouldery surface. Thompson also interprets the material along the south wall (left wall, looking at the headwall) and Blueberry Knoll as being the deposit of a rock glacier. As this writer has never seen what he knew to be a rock glacier, he would welcome any comments and observations by members of this field trip upon these features.

From Blueberry Knoll the Basin Ponds moraine and the associated belt of hummocky topography to the east are visible (see figure 1.). The Basin Pond moraine is a continuous ridge from Little North Basin at its northern end to the headwaters of Avalanche Brook at its southern end, a distance of more than three miles. In the vicinity of Basin Ponds, the moraine consists of nearly 100% granitic material, a fact noted by both Tarr (1900) and Antevs (1932). The Basin Ponds moraine extends far to the south of the cirques from which issued the glaciers that formed the moraine. Tarr, Antevs and this writer (1959, 1960) concluded that the Basin Ponds valley glaciers must have been dragged southward, away from their source, by a lingering, but still active tongue of the continental glacier in the Roaring Brook-Wassataquoik Stream valley. Such a relationship means that the Basin Ponds moraine is a medial moraine, formed between the confluent valley glaciers west of the moraine and active continental ice east of the moraine. The hummocky topography east of the Basin Pond may then be interpreted as a lateral moraine of the continental glacier, deposited after the ice had pulled back slightly from its merger with the valley glaciers.

It will be noted that granitic debris on the Blueberry Knoll moraine has a much fresher appearance than that exposed on the Basin Pond moraine. Bedrock exposures of granite at high elevations are weathered to about the same extent as the granite on the Basin Pond moraine. Fragments of granite in the ground moraine on the floor of the North Basin cirque and in the protalus rampart at the head of the cirque are weathered to about the same degree as the material on the Blueberry Knoll moraine. If one were to adopt the method which Blackwelder (1932) used in his studies of valley glacier stages in the Sierras, it might be concluded that the Blueberry Knoll moraine is a much younger feature than the Basin Pond mo-

SKETCH OF MT. KATAHDIN
showing
FEATURES OF SURFICIAL GEOLOGY
and
FIELD TRIP STOPS



TRIP C FIGURE I

raine. However there is a great deal of uncertainty involved in the application of the degree of weathering as a measure of relative age in the Mt. Katahdin region. On the one hand, rocks at high elevations above timberline are exposed to extremes in temperature and to wind. On the other hand, below timberline at such places as Basin Pond, chemical and organic weathering are more important. Blueberry Knoll lies between the zone of strong mechanical weathering and the zone of chemical and organic weathering. It is possible that the relative freshness of rock fragments exposed on Blueberry Knoll and on the floor of North Basin cirque is not a matter of age but of less intense weathering conditions.

Leaving Blueberry Knoll, we will descend into the Great Basin and South Basin. If the timing is correct, we will eat lunch at Chimney Pond.

4.1 miles (2½ hrs.) — STOP 4. Chimney Pond.

From the shore of Chimney Pond, in front of the Ranger's camp, the summit of Mt. Katahdin, Baxter Peak, is visible over the right edge of the pond. What appears to be a higher peak is South Peak, 27 feet lower in elevation than Baxter Peak (el. 5,267 ft.). From South Peak to Pamola Peak on the left, the serrated ridge of the Knife Edge arete is visible. There is an interesting petrographic difference in the granite of Mt. Katahdin. At lower elevations the granite is gray in color and at higher elevations it is pink. This change occurs approximately halfway up the steep cirque headwall in the foreground.

Chimney Pond is dammed by a small moraine which may have been formed at the same time as the Blueberry Knoll moraine. Half the elevation difference between the top of a cirque and a particular moraine has been used by some workers as a measure of the snowline during the formation of that moraine. Applying that approximation here, the two moraines appear to have formed under the control of a snowline of about 3600 to 3800 feet.

On the basis of his studies here and his experience in other regions, Thompson (1961) is able to conclude that the Chimney Pond moraine was originally substantially larger than it is at present. According to Thompson, during its deposition and for some time afterward, the Chimney Pond moraine was subjected to severe mass wasting, which accounts for its now modest size. Although he does not doubt that this moraine is now smaller than when it was deposited, this writer is not familiar with Thompson's methods of estimating the former or original size of moraines. If this writer interprets Thompson's conclusions correctly, Thompson feels that much of the material downvalley from the Chimney Pond moraine was carried away from the moraine by a rock glacier. If this were true and this material was originally all part of the Chimney Pond moraine, one would have to agree with Thompson that the Chimney Pond moraine was once a moraine of imposing dimensions.

Following brief excursions in the vicinity of Chimney Pond to observe some interesting talus accumulation at the Wash Basin and at the base of Pamola Peak, we will make plans for the remaining part of the afternoon. If the weather is at all threatening, we will descend to Roaring Brook and observe features of the surficial geology in the lowland. If the weather appears favorable, we can climb to Pamola Peak. This is a climb of about 1½ miles with a vertical rise of 2000 feet (more than we have already climbed from Roaring Brook to Chimney Pond) and should be undertaken only by those who are certain they are in good physical condition. For those who are not certain, please do not attempt this climb to find out. The leader will be grateful if those who do not feel in condition for this climb would readily volunteer to descend to Roaring Brook. It is urgently requested that those descending at this time do so in a group and either wait at Roaring Brook Campsite or leave explicit information with the Ranger there that everyone has gotten off the mountain. At Sandy Stream Pond, about a 10 minute walk from the Roaring Brook Campsite, there are invariably moose feeding and this curious operation can be observed and photographed at startlingly close range. It is estimated that the party going to Pamola Peak will arrive at Roaring Brook about 2½ to 3 hours after the party which does not go to Pamola Peak.

5.6 miles — STOP 5. Pamola Peak.

(4 hrs.) — Once the summit of Pamola Peak has been gained, this part of the trip has much to recommend itself. From the summit it is possible to walk along the Knife Edge arete, a memorable experience for any

who have not done it. The physical relations between the various moraines we have previously seen are well displayed from this vantage point. In the felsenmeer near the summit are numerous examples of miniature patterned ground. And finally, once the summit of Pamola Peak has been reached, it is approximately the same distance to Roaring Brook (3.4 mi.) by way of the Helon Taylor trail as it is from Chimney Pond by way of the Chimney Pond trail.

A note on the correlation of the Pleistocene sequence of Mt. Katahdin with that of south central and south western Maine.

This writer has made an intensive but abortive search in the Mt. Katahdin area for stratigraphically located organic material on which radiocarbon dates could be made. Pollen analysis of samples taken from several bogs in the region has failed to establish any correlation with the established New England pollen sequence. At this time, therefore, this writer has no valid basis for correlating Pleistocene events in the Mt. Katahdin area with those in other areas. However, one is always tempted to speculate upon possible correlations and the following speculations, based upon the recent work of Bloom (1960) and Borns (1963, 1965), are offered solely for the purpose of stimulating discussion during this field trip.

The best established late-Wisconsin unit in Maine is the Presumpscot formation of Bloom (1960). This unit is a marine silt deposited in a transgressive sea following the melting of the last continental ice-sheet which covered southern and central Maine. Radiocarbon dates of mollusc shells from the Presumpscot formation range in age from 11,000 YBP to nearly 13,000 YBP. Bloom (1960) has found evidence of a post-Presumpscot readvance (Kennebunk readvance) of ice into southwestern Maine from the White Mountains of New Hampshire. Borns (1963, 1965) also has evidence in the Kennebec Valley of central Maine of a post-Presumpscot readvance of ice which he feels may have been synchronous with the expansion of valley glaciers in the Mt. Katahdin area.

For the purpose of this discussion, we may assume that the last continental ice to be active in this area was pre-Presumpscot in age. The deposits of this phase of glaciation are the lateral moraine east of Basin Pond and the Basin Pond moraine, formed by the confluent valley glaciers from the large east-facing cirques on Mt. Katahdin. If the Basin Pond moraine was deposited during the pre-Presumpscot stage of glaciation, the Blueberry Knoll moraine then becomes a likely candidate as a deposit of the post-Presumpscot glacial event of Bloom and Borns, an event which Borns (1965) suggests may be correlated with the Valders substage of glaciation.

If there is any validity to the above speculations, we may find in them an explanation for the observed differences in the glacial features which are found on Mt. Washington and those of the Mt. Katahdin area. As we have seen, there is no doubt that one or more phases of valley glaciation followed continental glaciation in the Mt. Katahdin area. On Mt. Washington, on the other hand, the evidence is not so conclusive. The Goldthwaits (Goldthwait, J. W. 1916 and Goldthwait, R. P. 1939) noted the rather subdued nature of the cirques on Mt. Washington, their lack of prominent end moraines and the presence of glacial striae on the Tuckerman Ravine head-wall which are oriented more or less parallel with the direction of regional ice motion in that area. This evidence was interpreted by the Goldthwaits to mean that valley glaciation had preceded but had not followed the last continental glaciation in the White Mountains. Many other workers have felt, perhaps intuitively, that valley glaciation did follow continental glaciation in the White Mountains and have offered many interesting explanations as to why there is no evidence or at least so little evidence of this presumed post-continental stage of valley glaciation.

One of the most recent workers in this field is Thompson (1960, 1961), who suggests that the evidence of a post-continental stage of valley glaciation which the Goldthwaits did not find was removed by rock glaciers and other agents of mass wasting.

The speculations above on the timing of late-Wisconsin events in the White Mountains and the Mt. Katahdin area suggest another explanation for the observed differences in the two areas. It is possible that in post-Presumpscot times Mt. Washington was the center of a large ice cap and at the same time, Mt. Katahdin supported valley glaciers. The melting of these glaciers may have marked the end of important glacial erosion and deposition in the two areas. It might then be argued that the present day landscape features show the effects of icecap erosion and deposition in the White Mountains and of valley glaciation in the Mt. Katahdin area.

Trip C—Saturday

PLEISTOCENE AND SURFICIAL GEOLOGY BETWEEN TOGUE POND AND SOUTH BRANCH POND

Leader: D. W. Caldwell

The purpose of this trip is to get the members of Trip C as close to Shin Pond and the annual dinner as possible. Along the way there are many varied and interesting features of the surficial geology. The final portion of the trip will follow the route of the final portion of Rankin's Trip AS_1. The following quadrangle maps will be useful on this trip: Katahdin, Harrington Lake, Telos Lake and Traveler Mountain.

Road log. Distance measured in miles from Togue Pond Camps.

Time: 8:00 A.M., October 1, 1966.

0.0 Leave Togue Pond Camps.

1.5 Turn right on paved road.

5.0 Turn right off paved road to Baxter Park road. For the next 25 miles the road is narrow, with many turns and poor visibility of the road ahead. Please follow the car ahead of you at a prudent distance to avoid a series of rear end collisions. It is not necessary to always keep the car ahead in constant sight. You will know where he has gone by the dust.

6.0 Enter Baxter State Park.

9.0 Abol Campsite. This campsite is located at the foot of the Abol trail which follows the Abol slide. See the historical note of Griscom for accounts of early climbs using this route.

11.8 Katahdin Stream Campsite. The Appalachian Trail crosses here and its northern terminus is about 5 miles to the east, at Baxter Peak. From Katahdin Stream to Foster Field, Stop 1, the park road follows and crosses a small, but well defined esker. Many exposures in the esker show remarkably little coarse gravel. Some pits expose only fine sand, with minor amounts of pebble gravel.

14.5 STOP 1. Foster Field.

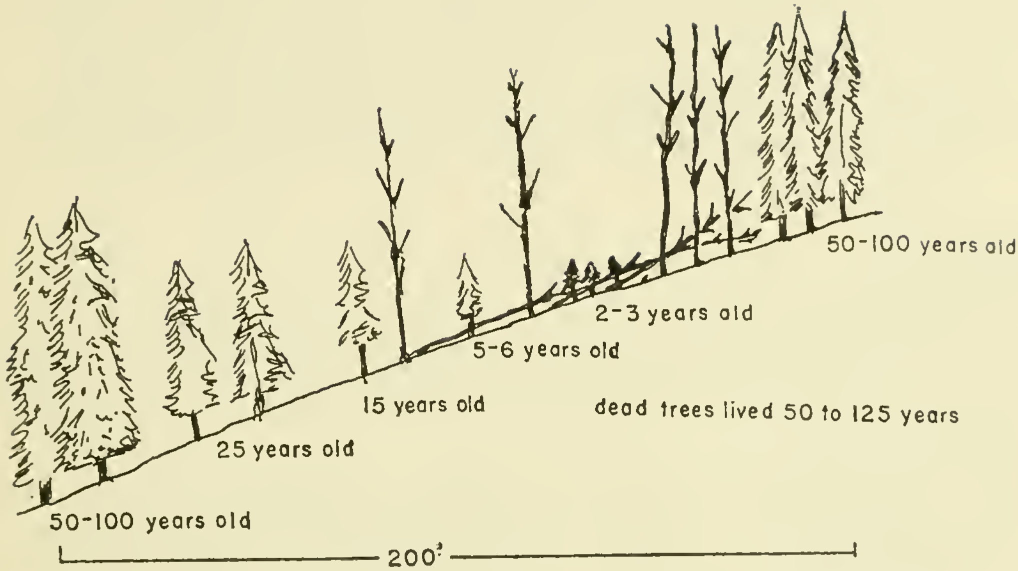
Numerous examples of landslide scars are visible. The thin drift cover has been removed and the underlying smooth, glaciated surface of granite is exposed. Of interest are the scars on O.J.I. Mountain, which formerly approximated the shapes of those letters. Continued landslide activity has nearly destroyed their original shapes.

From Foster Field several examples of curious patterns in the spruce forests at higher elevations are visible. Following the consensus of local opinion, this writer (Caldwell, 1959, 1960) described these features as blowdown formed during the 1938 hurricane. Dr. A. E. Brower (personal communication) of the Maine Forest Service called the writer's attention to several features which were inconsistent with this interpretation, not the least of which being that he had seen these features long before 1938. Dr. Brower also correctly pointed out that many of the trees in what appear to be areas of blowdown are still standing, although dead.

Although he as yet has no better explanation of these features than his original erroneous one, this writer has since examined some of the "blowdown" in detail and can present the following observations. A sketch showing the living and dead trees which occur along a line across one of these bands of "blowdown" is shown in Figure 2. The trees shown in Figure 2. were sampled in an area of "blowdown" between Mt. O.J.I. and Mt. Coe and the growth pattern of these trees is typical of that found in several other similar areas.

It seems apparent that the trees in question reach a certain age or a certain height and are killed. At some time following their death, the trees are blown over and appear to be systematically replaced by new growth. When this new growth reaches a certain age or height, it is killed and replaced by other new growth. Rather than being the result of a single event, the pattern in these spruce forests appears to be the result of a dynamic process. In the majority of cases which I have seen, the belts of dead trees more or less parallel contour lines. Once the process of death and replacement has been started in a band parallel with the contour of the

TRIP C FIGURE 2.



SKETCH SHOWING RELATION OF LIVING AND DEAD TREES

IN "BLOWDOWN" BETWEEN MT. COE AND MT. O.J.I.

slope, it appears that this band migrates upslope or perhaps in the direction of the strongest prevailing winds. The aspect of this pattern for which I have no explanation is how it starts in the first place. Of possible significance here is the occurrence on many of the forested slopes of bands of coarse debris which more or less parallel contour lines. These deposits are the result of solifluction or similar mass movement process. Perhaps the death and replacement is initiated along a band of coarse debris by the death of trees which are insufficiently rooted or without adequate available moisture.

19.5 Nesowdnahunk Stream ledges. Stream polished and potholed granite.

21.0 Nesowdnahunk Field. Turn right at road intersection. This and similar "fields" in the area were cleared for raising hay for horses and cattle used in lumbering operations.

24.5 STOP 2. Nesowdnahunk Lake.

To the south several well developed cirques are visible. Although these cirques are below timberline and do not present such a dramatic appearance as the North Basin cirque, they are fully as fresh as those seen yesterday. These cirques also contain well developed end moraines which are weathered to the same degree as the Basin Pond moraine and are tentatively correlated with that moraine.

This writer has found no fragments of Katahdin granite in deposits of drift or in stream channel sediments north of the northern bedrock contact of this rock type. It therefore appears unreasonable to postulate any major outflow from an icecap located on Mt. Katahdin following the last continental glaciation, as has been suggested by Flint (1951). Although the flat Tableland surface on Mt. Katahdin may well have had a small ice cap which fed into the valley glaciers in the cirques below, flow from this ice cap did not extend beyond the end moraines at the mouths of these cirques.

39.0 STOP 3. Trout Brook Crossing.

We will want to leave several cars here to transport drivers of the cars which will be left at South Branch Pond (Stop 4). The relative discomfort of the crowded cars from here to South Branch Pond will certainly be no greater than a general hike over the same route following our afternoon excursion.

Within a short distance of the Crossing the South Branch Pond road crosses several large, dry or nearly dry channels. These channels, cut in both till and bedrock, are not organized into drainage nets. The streams which do occupy these channels are underfit for them. If one uses the relation between channel width and discharge as an approximation of discharge, it may be estimated that these channels were cut by streams with discharges of more than 1000 cubic feet per second. By way of comparison, such discharges now occur in this region as the 2.3 year frequency flood in drainage basins of about 50 square miles area. These features are thought to be ice marginal drainage channels formed during the melting of the last continental glacier in this area. The shape, size and extent of these channels are well shown on the Traveler Mountain Quadrangle and on aerial photographs which will be available for inspection.

41.2 STOP 4. South Branch Pond.

If the estimated time of arrival is correct, we will eat lunch at the campgrounds. There are several interesting features to be seen from here, and depending on how much time we have, we will observe them from the shore of the pond while eating lunch or from a bare rock ledge about .4 mile from the campground.

Facing the pond, North Traveler Mountain is to the left and Traveler Mountain is seen over the far left end of the pond. The summits of neither mountain are visible from the shore of the pond, but both may be seen from the ledge overlook. Several valleys in these mountains end upstream in cirque basins. These cirques contain thick deposits of till with a majority of erratic material and the walls of the cirques are quite subdued. I have found no end moraines in any of them. This evidence means that, unlike the Mt. Katahdin cirques, the Traveler Mountain cirques did not contain valley glaciers following the final episode of continental glaciation in the region. This difference can probably be explained by the lower elevation of the Traveler Mountain cirques.

At the south end of the pond is a large delta. This delta has divided an originally two-mile long lake into the present Upper and Lower South Branch Ponds. Certain hydrologic considerations suggest that the present stream flowing over this delta does not have the competency to have deposited the delta. It is likely a relic feature, formed at some time in the past when the streams in this area had greater discharges and greater competency, possibly during the post-Presumscot glacial event mentioned on yesterday's trip.

From South Branch Pond we will follow the route of the final portion of Rankin's Trip AS_1, which is described in another part of this guidebook. This excursion will end at Trout Brook Crossing, where we will see if the plan for retrieving the cars left at South Branch Pond actually works. Once all cars are reassembled at Trout Brook Crossing, we will proceed to Shin Pond for the annual dinner. It is about 25 miles to Shin Pond and the dinner will be at Mt. Chase Lodge, signs pointing to which will be prominently displayed. For those who are returning to Togue Pond after the dinner, it is recommended that you do not return through Baxter Park, but continue on from Shin Pond toward Patten, thence to Sherman Mills, Grindstone, Medway, East Millinocket and Millinocket. This route is somewhat longer than returning through the park, but the road is much better.

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